THE

# STORY OF PLANT LIFE IN THE BRITISH ISLES

VOLUME III

FRONTISPIECE.

THE STORY OF

# PLANT LIFE IN THE BRITISH ISLES

(*TYPES OF THE NATURAL ORDERS*)

WITH AN INTRODUCTION, IN WHICH ARE EMBODIED GENERAL BOTANICAL PRINCIPLES

**VOLUME III**

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*WITH 121 ILLUSTRATIONS FROM PHOTOGRAPHS*



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TO MY WIFE

# PREFACE.

THIS volume concludes the series of three which has been published in order to give an idea of the *natural orders of the British flora*, of which there are ninety. The number of species described amounts approximately to 250, a type, or more than one type, of each order, or section of each order, being included.

In addition, the Introductions deal with the *main principles* of botany in brief, and illustrations have been drawn for this purpose from the plants described in the systematic portion, it being desired that the systematic study shall lead up to or be followed up by that of the general morphology, physiology, and other branches of botany. I do not think an inversion of this process is so likely to help the beginner.

The *British flora in itself affords an admirable selection of plant types for study upon any lines* over and above the systematic. If the latter is made interesting by attempting to give a life-history of each, with details of pollination, etc., it may be

the means of stimulating interest in other than the purely taxonomic aspect of botany, of equal importance though this be. For sufficient attention has not been given to the British flora in the study of these other branches, though it lends itself admirably to the illustration of them. Hence the main *motif* of the work is to stimulate this interest on the lines here suggested for accomplishing such an end (and see Appendix II).

Throughout the illustrations should serve as a permanent record of the types intended, and prove of value incidentally in determining the plants in many cases.

I have to thank Miss C. E. C. Measham for reading MSS. and proofs for me, and for other help.

For the drawings I am indebted to Miss Emmeline Radford. For the photographs I have to thank Messrs. W. Bell, H. A. Cox, J. H. Crabtree, F.R.P.S., the late G. B. Dixon, C. Edwards, F.R.P.S., Messrs. Flatters and Garnett (who have placed me under great obligation), T. R. Goddard, the Rev. C. A. Hall, Messrs. B. Hanley, H. G. Herring, L. R. J. Horn, C. R. Mapp, F.R.M.S., B.Sc., W. E. Mayes, C. Mosley, and A. Newton.

In Volume II by an oversight the word "copyright" was omitted after the name of Messrs. Flatters and Garnett, and I gladly take this opportunity of rectifying the mistake.

Those who wish to make a further study of the orders or subjects discussed are referred to the appendices to each volume, where bibliographies will be found.

The 'Dictionary of Plant Names' has been utilized in the citation of the English names, and where helpful other works mentioned in the bibliography have been laid under contribution, my thanks being tendered to the respective authors for the assistance thus rendered.

It is hoped that the notes in Appendix II will prove useful to those who wish to undertake *practical* work, which is as essential to success in this as in other fields.

A further feature is the synopsis of orders, genera, etc., following Engler and Prantl, and based partly upon Dr. Carter's summary, with amendments by Dr. C. E. Moss, whose new 'British Flora' is modelled on the same lines.

A. R. HORWOOD.

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* In each case where photographs by Messrs. Flatters and Garnett are acknowledged "copyright" is to be understood.

# THE STORY OF PLANT LIFE IN THE BRITISH ISLES

## VOLUME III

## INTRODUCTION—(*Continued*)

### 10. Germination and Growth.

HAVING described in Vol. II the relationship of the transporting agencies in the plant, and the factors in the environment, to the processes of nutrition, and to the transported materials, in their general bearing upon the essential factors in the plant's activities, nutrition and growth, we proceed to discuss briefly the main sequence of events that take place during the life-cycle of the plant from germination to fruit- or seed-formation.

The seeds of a plant may be protected by a soft or a hard seed-coat or testa and may lie either enclosed in the fallen fruit, or they may, before falling from the parent plant, be expelled from the fruit, and be scattered as seeds. In either case the young embryo in the seed is efficiently protected against the exigencies of a hard winter, as in this country, and during the quiescent period, after it has fallen from the

parent plant, remains inactive in the soil, exhibiting no living characteristics, until the external conditions make for its entrance into the world of life.

The embryo in this state is provided with endosperm in most Monocotyledons, a large proportion of which are aquatic, and usually herbaceous. Amongst Dicotyledons, however, there are seeds with endosperm, which are called albuminous, and those without endosperm or exalbuminous. In the former case the endosperm serves as reserve material upon which the embryo can draw in the early stages of germination before the cotyledons have become functional, or before the first leaves have appeared. Where there is no endosperm the cotyledons themselves are large and supply the necessary material for setting in motion or starting into being the activities of the young plantlet or embryo.

In the seed the embryo is already differentiated, with a radicle which develops into the root, on germination, and one or two cotyledons according as the plant is a Monocotyledon or a Dicotyledon, which subtend or enclose a plumule or bud which gives rise to the stem. Around these lies in albuminous seeds the endosperm which may be mealy, oily, fleshy, or horny. The seed-coat may consist of one coat or two. In the latter case the inner coat is the tegumen, the outer the testa. Sometimes an arillus surrounds the latter, as in the Water Lily, or a caruncle may be formed.

The seeds may be large or small. The former are


FIG. 1.—TO ILLUSTRATE GERMINATION OF SEEDS IN GLASS BEAKERS.
*Emmeline Radford, del.* *See page* 3. *W. E. Mayes, photo.*

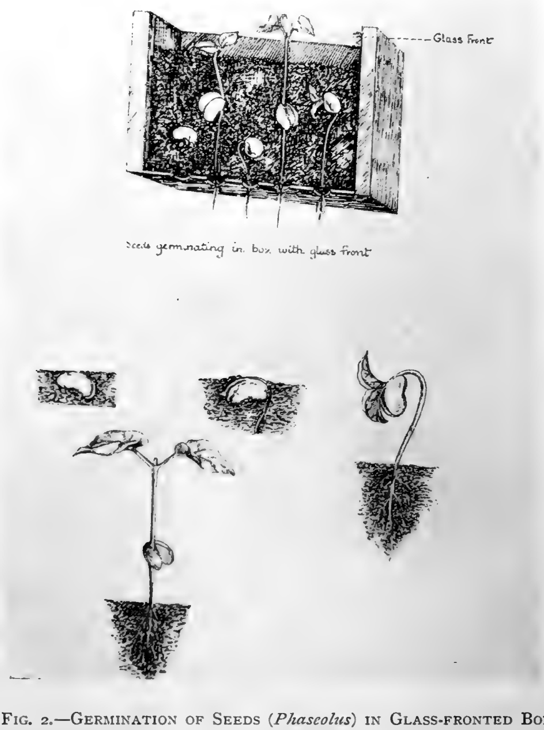


FIG. 2.—GERMINATION OF SEEDS (*Phaseolus*) IN GLASS-FRONTED BOX.
*Emmeline Radford, del.* *See page* 3. *W. E. Mayes, photo.*

generally for each plant few in number and well protected, so that in the struggle for existence they may survive. In the case of small seeds large numbers are produced, and they are not always so well adapted to resist the agencies that exist to render them useless in the perpetuating of the race, such as birds that are seed-eaters, etc. The embryo itself may be large or small. Where it is large germination is usually accelerated.

In exalbuminous seeds, those without endosperm, the cotyledons have various arrangements which are important in classification. They may lie parallel and rolled up, as in the Sycamore, or they may be doubled, as in the Radish, or be twisted edgeways. They may be divided into 3 lobes or plaited. The radicle may lie turned over the back of the cotyledons when it is incumbent, as in round seeds. If it is turned along the edge of the cotyledons it is accumbent, as in longer seeds. These arrangements are thus adapted to the form of the seed.

The embryo has the faces of the cotyledons turned to the placenta as a rule, or the edges may be turned to the placenta. These arrangements are connected with the mode of exit of the cotyledons from the seed.

The stages of germination are best understood by growing a number of seeds. The seeds can be conveniently grown in glass beakers or boxes (see Figs. 1 and 2), the sides of the beaker being lined with blotting-paper and the inside loosely packed with damp moss. The seeds should be soaked for twenty

hours and then placed between the blotting paper and the glass.

It is proposed briefly to outline the germination of a pea, a mustard seed, and a grain of wheat.

The first sign of germination in a pea (see Fig. 3) is the splitting of the skin in the neighbourhood of the radicle. The radicle itself soon emerges and grows downwards. From one to two days later a curved stem-like structure pushes out of the seed above the stalks of the cotyledons. This is the epicotyl; in plants grown in soil it appears above the ground as a little loop. As the epicotyl grows longer the plumule emerges from the seed and at length appears above the soil. The epicotyl then straightens itself, the plumule becomes erect and begins to develop. The first leaf structures are small. They become separated by the growth of the first internode. As the second internode grows the first true leaf gradually unfolds. The radicle meanwhile will have grown in length, root-hairs will be distinguishable a little way above the root-tip, and on the older part of the radicle branches may have already appeared. As the plant grows and other leaves unfold the root-system will also develop, but the main axis of the root will remain distinct even though numerous branches are formed.

In this type of growth the cotyledons are said to be hypogeal, as they remain enclosed in the seed while germination goes on.

In the mustard also (see Fig. 3) the radicle is the

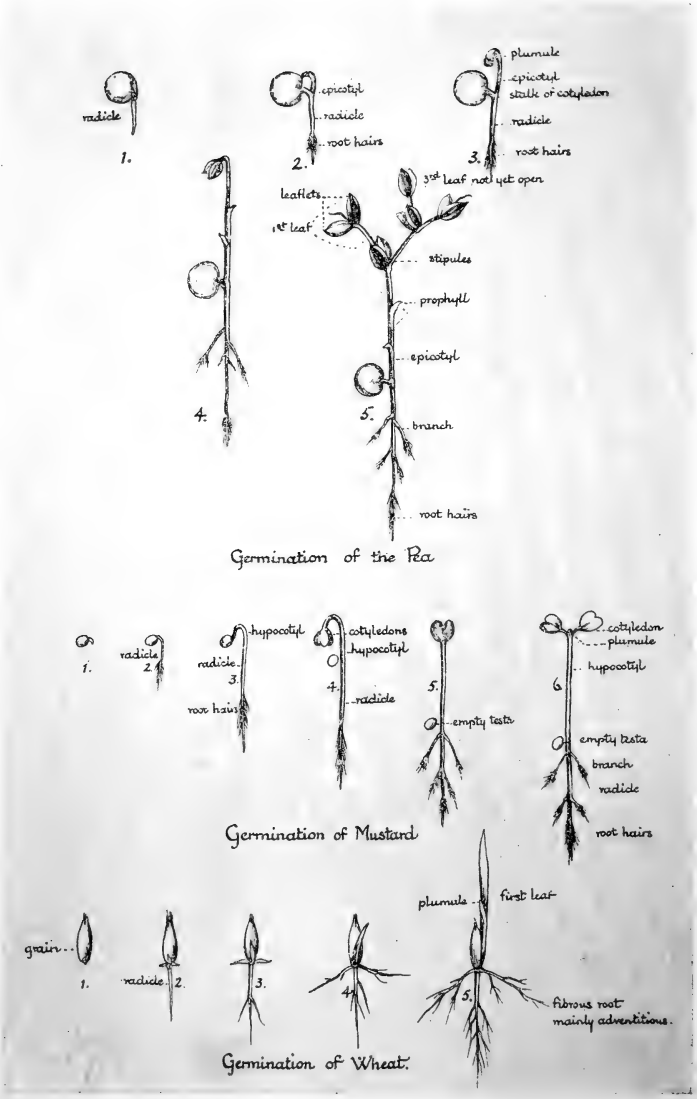


FIG. 3.—GERMINATION OF PEA, MUSTARD, WHEAT SEEDS.

*Emmeline Radford, del.* *See pp.* 4–5. *A. Newton, photo.*

first structure to emerge from the seed. It grows downwards. Then a curved-over stem structure emerges below the cotyledons and grows upwards. This structure is the hypocotyl. As the hypocotyl grows the cotyledons gradually emerge from the seed and appear above the soil. The hypocotyl then straightens and the two cotyledons which have become green unfold and assume a horizontal position. The radicle has meanwhile grown longer, and the root-hairs are very clearly seen. It is some time before the true plumule develops in this case, a considerable growth of root with branching having taken place before the first true leaf unfolds.

In this type of growth the cotyledons are said to be epigeal, as they appear above the soil.

In both the pea and mustard the first stem structure to appear is curved and in both the same kind of root system is formed.

In the grain of wheat (see Fig. 3) the radicle emerges first; its appearance is very shortly followed by that of one or two other root-structures which appear at the side and might be mistaken for branches. If, however, growth is allowed to continue it will be seen that the number of these root-structures increases, and if the germinated grain is carefully dissected it will be seen that these structures arise above the radicle on the main axis of the embryo. These roots are, therefore, adventitious. In a very short time it is not possible to distinguish the radicle among the numerous roots, and thus a root-system results,

which is on a different plan to that of the pea or the mustard.

The end of the main axis of the embryo opposite the radicle is pointed in the grain of wheat. It appears outside the grain shortly after the radicle and grows straight upwards. The first leaf-structure has no blade. The first true leaf has both a sheath, which almost encases the stem, and a blade which gradually unfolds and assumes a position more or less vertical.

It will be seen that the above account includes three types of germination. It is possible to distinguish a fourth. In the mustard there is no endosperm, but many dicotyledonous seeds with endosperm have epigeal cotyledons.

The germination of the pea and mustard may be taken as typical of Dicotyledons, that of wheat as typical of Monocotyledons. There are numerous details in which individual species do not conform to types, so that the study of germination gives a wide field for observation.

At a still later stage in most cases it is possible to make out that the radicle has developed into a root with a main axis and a root-tip, and above this are root-hairs for absorption.

Rootlets are also given off at an angle with the main root. In Leguminous plants root-tubercles with bacteroids are soon developed.

At the opposite extremity the shoot has a main axis or stem. This bears leaves. In the axils are buds, which in turn give rise to branches. The

leaves may or may not have stalks or petioles, and in some cases there are stipules at the base of the latter. The leaves may be compound and made up of leaflets.

In such a stage of development growth,* unless arrested, goes on, and the further stages, such as movements in response to stimuli and special contrivances for race perpetuation or reproduction, are rendered possible. But all these manifestations of energy are only exhibited if the young embryo be living, and be provided with a suitable supply of water, heat, air or oxygen. Till the food materials reserved in the endosperm or cotyledons are exhausted there is no special call for the other factors, such as light or nutrient salts. But when they are these two factors must be forthcoming in order that absorption and photosynthesis may serve to carry on nutrition, or otherwise growth ceases, and the plant will die or wilt. They are necessary for the performance of the other functions described in vol. ii (Introduction).

## II. The Movements of the Plant. Response to Stimuli.

Even in the seedling stage the plantlet responds to two classes of stimuli, those of gravity and light. The terms geotropism and heliotropism are used in connection with the response of the plant to these stimuli.

When, however, a plant has begun to obtain its own food from the air and the soil, or water in the case of aquatics, these classes of stimuli are over-

* *Vide* also p. 8.

shadowed by other movements that operate in a different manner.

Collaterally with all such movements there is, of course, the effect of growth in length, caused primarily by the influx of new food materials, the passage of these to the growing point, the rapid division there of undifferentiated cells, and their subsequent formation into complex cell-layers and tissues. Growth is a process of elongation, vertically and horizontally, as a result of the elaboration of organic substances in the plant body, and its consequent accessions of new formed cells or tissues at every extremity where a growing point is established.

Movement is primarily due to certain sense perceptions that plants possess.

Jung stated, with regard to the idea that plants possess consciousness, "*Planta est corpus vivens non sentiens.*" Linnæus said: "Minerals grow; plants grow and live; animals grow, live and feel." Undoubtedly there is a certain kind of parallelism between the characteristics of plants and animals, especially noticeable in the lower grades of each, in so much that there are many lowly organisms which are regarded as plants by some observers and as animals by others, it being extremely difficult to determine what is the difference between a plant and an animal. Opinions upon this point to-day are, indeed, still unsettled. The Mycetozoa are an instance of this. They are placed in the plant kingdom on account of their mode of reproduction and

resemblance to fungi. But they exhibit a curious resemblance to the movements of Amœba, a Protozoan, in the streaming or creeping motion of the plasmodium. They also resemble Amœba in mode of nutrition.

For this and other reasons a common kingdom Protista has been suggested for the lower types of plants and animals, viz.: Protophyta and Protozoa. Professor Keeble, moreover, has shown by his researches on *Convoluta* that certain organisms may properly be called "plant-animals."

All the old distinctions between plants and animals, *e.g.* power of movement, once supposed to be a characteristic of the latter, have had to be discarded as innumerable exceptions to such rules have come to notice.

Moreover, the jelly-like colloids, about which so much has recently been said, are very similar in the case of minerals, plants, and animals, so that, on a physical basis, life—which is even accredited by some to minerals—has three types of manifestation. In the mineral each type follows certain fixed laws of crystallisation, and once this is accomplished its work is done so far as we at present know. A plant also has a definite mode of development, and exhibits definite forms of living activity continuously. Animals again develop in their way activities of a kindred kind. Thus all three grow, divide, multiply, and exhibit affinity for kindred forms along certain lines.

But there are grades between each of all these similar types of activity or forms of materialisation or matter. The mineral exhibits no semblance of adaptation to external conditions, except that of arrangement or association in relation to contact, or contiguous mineral individuals. Its existence, in cracks, veins, etc., is, moreover, entirely fortuitous. In other cases it is not so, but dependent upon certain conditions.

A plant exhibits many of the forms of response to stimuli that an animal does, but in one respect is markedly different, being relatively fixed (like the mineral which is entirely so), whilst an animal (in most cases) can move. So that this introduces wide differences in the behaviour of each.

Coming to the special bearing of these stages in each of the three main realms of nature, there are certain resemblances between the character of the movements (and other types of activity), or response to stimuli, between plants and animals, that suggest that the former, like the latter, possess a definite consciousness. But what distinguishes the higher animals (and so far as present knowledge goes, only these, and not the lower types) is the possession of *self*-consciousness.

The animal is essentially a liberator of energy, the plant stores it up. This is a consequence of the modes of nutrition which differ so widely, and the entire dependence of the former upon the latter.

Fundamentally the response of the sense-organs of

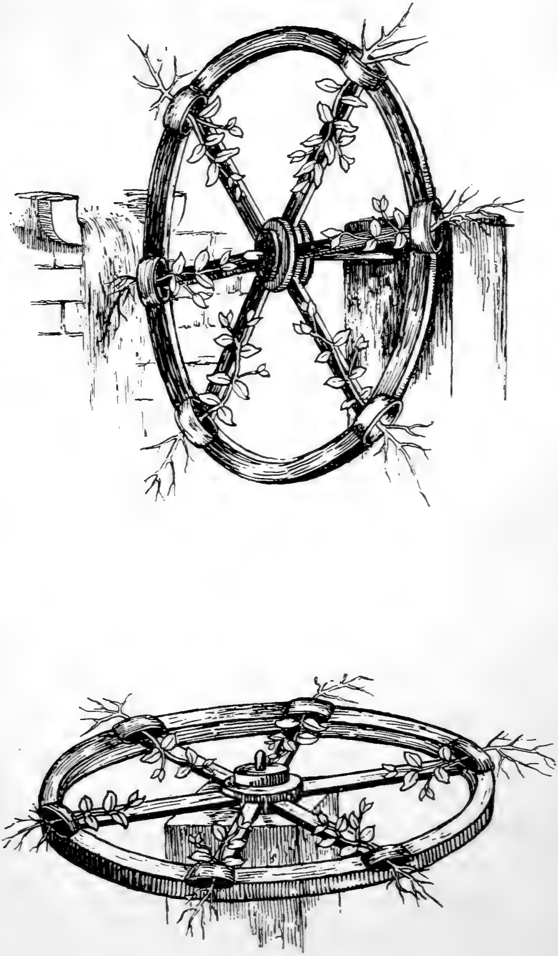

FIG. 4.—KNIGHT'S WHEEL, A DEVICE TO COUNTERACT THE ACTION OF GRAVITY UPON PLANT GROWTH.

*Emmeline Radford, del.* *See page* 11. *A. Newton photo.*

plants to stimuli is all of the nature of irritability. This has reference to the necessity of self-preservation, and it may be added that even a mineral, which has never so far been accredited with any definite type of sensibility, has the power of repairing injury.

There is thus a kind of progressive development, parallel for the same type of activity, in each of the three realms or states of nature.

There is little to distinguish the sense of contact common to plants and animals from irritability. In animals which have other senses such as sight, hearing, smell, taste, and the power of speech, etc., however, it is developed into the sense of touch. In plants it is rare, and found mainly in insectivorous plants and in climbing plants.

The stimulus which causes plants to extend the root downwards is gravity, a force which equally affects all matter. By a mechanical device Knight (see Fig. 4) overcame this force and caused roots and stems to develop at an angle of forty-five degrees to the vertical, whereas under gravity plants place themselves parallel with the direction of its force, or normally vertically. The effect of gravity, however, does not extend in direction to the lateral root or stem branches, and these grow out at right angles or obliquely, and are diageotropic. This power of movement then is distinctly connected with growth. But the power of the root-tip to respond to gravity is only found in the cells at the tip, and if the growing point is destroyed there is no response to the

stimulus of gravity. Hence responses to stimuli are localised or special adaptations to meet special forces. The stimulus may be communicated to surrounding cells, but only for a short distance.

Another stimulus which causes plants to exhibit movements is light. The response to this factor is called Phototropism, or Heliotropism. In this kind of movement plants place themselves or their stem structures parallel with the direction of the light, but the leaves of plants in a window, or the flowers, in the case of sun plants, during the day which turn their flowers to the sun, *e.g.* Rockrose, are at right angles. The movement may be towards the light when it is positive, or away from it when it is negative as in roots.

The leaves take up a position at right angles to the rays of light, and are then diaheliotropic. The stem of the Ivy which clings to a wall or tree is also more or less diaheliotropic. It is the violet-blue rays that influence the movements due to phototropism.

The response to contact with a supporting structure, exhibited by trailing and climbing plants, is again a type of movement, seen in the tendrils of the Clematis, or the rootlike structures on the stem of the Ivy. The roots of plants also exhibit the same kind of sensibility to contact.

Root-hairs further exhibit a certain affinity for nutritive substances or solutions in the soil, and this is a sensibility of a chemical nature.

Hydrotropism is a movement of the roots or root-hairs towards the moisture in soil, and, according as it varies, the direction of growth varies.

There are also movements which are due to the alternation of day and night or alternation of temperature. These are called nyctitropic movements or "sleep movements." In this case the leaflets of certain plants close up or assume a vertical position at night, as in the Woodsorrel (see vol. ii, Fig. 32, p. 168). They are possibly thus protected from frost or cold.

Flowers close up during the night and in wet weather to protect the essential organs, or stamens and pistil, as well as the pollen and honey, from cold.

The irritability of the tentacles of the insectivorous plants is another form of movement connected with their special mode of nutrition (see under *Drosera*, vol. ii).

Each organ of the plant exhibits different degrees of irritability or response to stimuli in relation to nutrition or other factors.

The root responds to the stimuli of gravity, light, temperature, moisture, water, nutrient solutions, electricity, injury.

The shoot responds to the stimuli of light, contact in the case of climbing plants, and internal reactions such as carpotropic movements and to injury and electricity.

The leaves respond to light or heat, or generally to the sunlight in relation to nutrition.

The flower responds to the stimulus of heat in the

hastening on of the reproductive process, and the seeds to the distributive agencies preparatory to germination, in which stage the seed reacts towards the stimuli of water, light and oxygen.

Thus, then, the sensibility of a plant is localised in different organs, all elaborated with a view to ultimate nutritive and growth functions. There is a division of labour, but no co-operative force or system, such as is seen in the nervous system of animals. There may be analogy here, but no real parallel, except physiologically speaking.

### 12. Reproduction, Special Contrivances for Race Perpetuation.

Some of the organs of a plant are vegetative, as the root, stem, and leaves. These have special functions connected with nutrition and growth. But they are also capable of *propagation*. Roots divide and give rise to new plants. Stems may multiply, and as rhizomes, etc., give rise to new plants. Leaves may develop buds which may root and become separated, and thus also give rise to new individuals.

The other organs are the flowers which are *reproductive* organs, which by a process of cell-division and subsequent cell-fusion and multiplication, produce a new individual with the original germ-plasm, but without the soma of the parent individual, the germ-plasm itself giving rise to the new body-plasm.

In vegetative propagation there is no such interchange of sexual elements; the plant cells extend

and continue by division, and one body separates from the other. The cells remain the same. This is one form of asexual reproduction. The germ-plasm, which lies wrapped up in the nucleus of each cell, is in this case removed into a different room, as it were, whereas in sexual reproduction the entire rearrangement of the special germ-cell which carries on the race may be compared, on fusion with the sperm of the opposite sex in a different flower, with the building of a new house from an old with the same materials, but arranged on a different plan. A sperm-cell and an egg-cell fuse, division occurs, both nuclear and cell-division. In the ripe egg-cell the sperm-nucleus fuses with the egg-nucleus, and the chromosomes of the former are added to those of the latter and are thus doubled, remaining distinct but joined at the extremity, but half are removed so that the original number remains. The paternal and maternal characters in both sperm- and egg-cell were first halved in the cell-division and nuclear-division preceding fertilisation. After reduction and division or mitosis, the paternal chromosomes and characters of each are brought together with the maternal characters of each, and in place of one kind there are two kinds. In the case of the male and female cells the grandmother cells* formed from the sporogenous

* The segregation of chromosomes by the division of the grandmother cells is the reverse of the process when the egg is fertilised, where the number of chromosomes is doubled, whilst in the former it is halved. We may thus speak of an $x$ generation and a $2x$ generation. This is conformable with Mendel's laws.

cells there are paternal and maternal chromosomes in pairs; in the spore mother cells they are associated in pairs, the paternal and maternal parts of each pair congregating at different poles. So two cells in place of each former one are paternal, two maternal, at each pole. Each chromosome divides, and one-half of them travelling to one pole is paternal, the other going to the opposite pole is maternal, making four. Nuclear division may occur in cell-division vegetatively, since each new cell must have a nucleus by the division of one original into two new ones. In reproduction the special cells divide, and in fusing the contents interchange.

In the case of propagation vegetatively adventitious roots may be produced, springing from the stem base, or such roots may develop on rhizomes, runners and other creeping stems at joints where leaves or buds form. Without such adventitious roots it would not be possible to strike cuttings, and in layers they are also developed. Suckers are dormant buds developed below the surface.

Adventitious buds may be developed on the stem, leaves, and even roots. Or they may form upon detached parts of a plant, as in the begonia leaf, scales of bulbs, etc., and if roots later develop, as is usual, they give rise to a new plant.

In stems where superficial runners or stolons occur buds develop with adventitious roots at the nodes, and, the internodes dying away, fresh plants spring up.

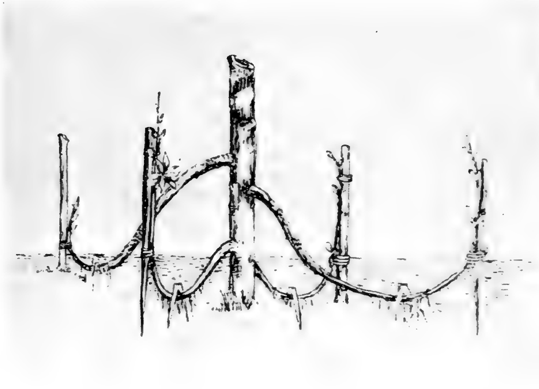

FIG. 5.—VEGETATIVE PROPAGATION BY LAYERS.

*Emmeline Radford, del.* *See page* 17. *W. E. Mayes, photo.*

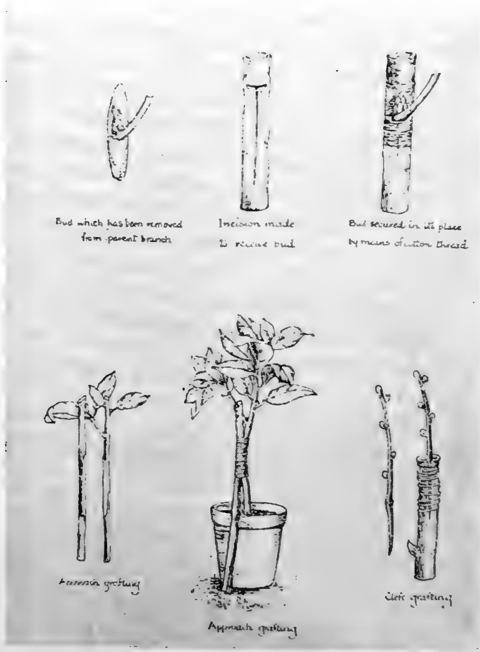


FIG. 6.—VEGETATIVE PROPAGATION BY BUDDING AND GRAFTING.

*Emmeline Radford, del.* *See page* 18. *W. E. Mayes, photo.*

In underground stems, *e.g.* a rhizome or root-stock, the leaves are scaly, and adventitious roots form at the nodes. The main axis may be entirely underground, or become partly aerial at length. If in the last case the rhizome is broken away a new plant forms. Suckers are developed on stems and roots of shrubs and trees, and when adventitious roots form and the suckers are separated from the parent plant they form new plants.

Tubers, corms, bulbs are shortened shoots or enlarged stem bases which divide, and on separation give rise to fresh plants, the new corms, etc., being formed below the old ones, or above, or laterally. On leaves buds may form along the margin and develop roots, as in the Cuckoo flower, etc., and give rise to new plants.

By artificial means it is possible to reproduce plants by cuttings, either part of a root, stem, or leaf. The best method is to select a shoot, broken just below a node, from which, when struck, adventitious roots are given off. In trees a part of the original stem, or heel, is usually included.

In the case of layers a shoot is bent down and pegged into the soil by a U-shaped peg inverted like a croquet hoop. The shoot is half nicked or cut below, and roots develop from the half-severed part. Finally the layer is completely isolated, and a new plant is formed in this way. (See Fig. 5.)

Other methods of artificial propagation are budding and grafting. In the former case a bud is selected

and placed upon another stem or stock, the new bud becoming eventually part of the stock upon which it is inserted. (See Fig. 6.)

A graft or scion is obtained by inserting a shoot with buds in a similar manner upon a stock. The scion and the stock each exhibit and retain their own individual characteristics. A graft-hybrid is one in which the characters of scion and stock become blended. Recently doubt has been thrown upon their existence as such.

Turning now to the process of reproduction, pure and simple, by sexual methods, we have to deal with the union of a male cell with a female cell, and after fusion the resulting new cell or product of the two. (See Fig. 7.)

The original male gametes are formed in the pollen-grains furnished by the stamens, often called the male organs. The pollen-grains are contained in pollen-sacs or microsporangia and equal the microspores of lower types of plants, and each pollen-grain contains the two nuclei, the one vegetative, the other generative or the male, or sperm-cell. The female reproductive cell is furnished by the ovule or megasporangium, and the egg-cell is the ovum or oosphere. The embryo-sac is the megaspore. The result of fertilisation is the growth of the embryo, which forms with adjacent structures in the ovule, the seed, a characteristic of Spermatophytes.

The embryo is a dormant sporophyte, derived from a reduced oophyte. The endosperm represents the

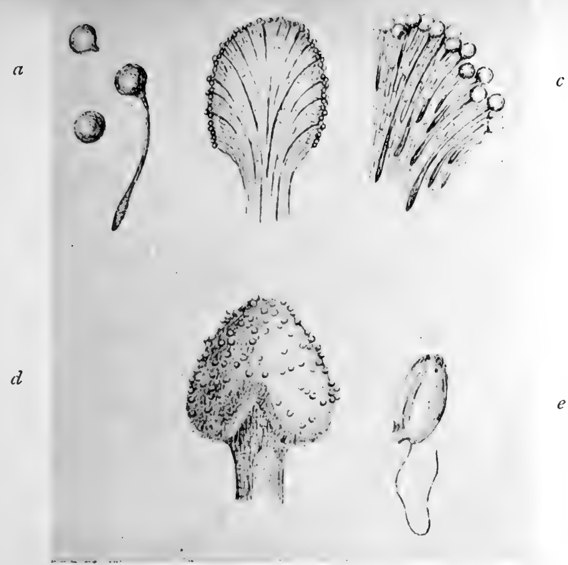


FIG. 7.—POLLINATION AND FERTILISATION OF A FLOWER.

*a.* Pollen-grains, one with pollen-tube. *b.* Stigma in section, with pollen-grains adhering and penetrating the style. *c.* Pollen-tubes descending the style. *d.* Stigmatic surface covered with pollen-grains. *e.* Pollen-tube penetrating the micropyle.

*Emmeline Radford, del.*


FIG. 8.—POLLINATION AND FERTILISATION OF A FLOWER.

*a.* Section of ovule before fertilisation. *b.* Section of pistil with anthers, stigma, pollen-grains, and ovules. *c.* Pollen-tube entering the micropyle, ovule after fertilisation. *d.* Section of nucleus with pollen-tube. *e.* Formation of the embryo. *f.* Pollen-tube after entering nucleus.

*See page* 18.

*W. E. Mayes, photo.*

vegetative part of the prothallus of the Gymnosperms. The gametophyte or sexual generation in the fern gives rise to the antheridia and archegonia, the fern plant being the sporophyte, or that which we usually term the plant in Angiosperms. In the Angiosperms and Gymnosperms the oosphere awaits fertilisation, and in each case it develops from the prothallium.

In Angiosperms the pollen-tube may be regarded as representing an antheridium, and the archegonium, now reduced, consists of the oosphere and synergidæ, and is enclosed in the ovule, and this in an ovary. The antipodal cells at the bottom of the embryo-sac may represent a prothallium. They do not contribute to the development of the embryo and disappear. Such in brief are the homologies between the structures of seed-plants and those of so-called non-flowering plants or Cryptogams.

Reverting to the germination of the male cell or microspore, and the germination and fertilisation of the female cell or megaspore, the stamens are the male organs and consist of a filament with an anther and anther-cells, which contain pollen-grains. Pollen is variable in size, form, shape, with an inner and an outer coat or intine and extine. Inside the pollen-grain consists of cytoplasm with two large cells, the generative cell and a vegetative cell. If the pollen-grain is placed upon a stigma it develops, and a pollen-tube from the intine grows out of the vegetative cell. The nucleus of the latter is lost and the

male cell divides into two. The pollen-tube going down the stigma and style penetrates the micropyle and passes into the ovule ready to fertilise the egg-cell.

Turning to the maturation of the embryo-sac, in the middle of the ovule is the nucellus enclosed in two (or a single) integuments, except at the micropylar end. The ovule and the integumentary tissue unite below in the chalaza. When all are in a straight line the ovule is orthotropous. If the micropyle lies close to the funicle or stalk of the ovule it is anatropous, and campylotropous when the nucellus and integuments are bent over laterally.

In the nucellus when the megaspore has matured the embryo-sac is developed near the upper end. The nucleus divides into two, and one cell goes to each pole. They divide into four, one of each returning to the centre to form the secondary nucleus, replacing the first. It has thus eight cells which are formed by the division of the nucleus.

The lower three cells are the antipodal cells. The upper three are the egg apparatus, consisting of two synergidæ and the ovum or egg-cell.

When fertilisation is about to take place, the male cell fuses with the ovum, and as a result of this, or fertilisation, the embryo is formed. One male generative cell fuses with the egg-cell. The ovum or egg-cell divides and grows and develops into the embryo. The ovule with the ovum and the integuments thus becomes a seed.

As regards the development of the embryo, the

ovum forms a cell-wall and divides into two cells. The upper forms a single row of cells, the suspensor. The lower is the embryo-cell, which forms the embryo, except the radicle formed from the hypophysis or tip of the suspensor. The embryo-cell divides into eight cells, four to form the hypocotyl and radicle, the other the cotyledons and plumule. The synergidæ and antipodal cells disappear.

The secondary nucleus divides up, with cell-walls, and forms the endosperm which serves as a reserve for the embryo. It is used up before the mature seed is formed in some plants, in others it is not. The nucellar tissue is also largely used up as the embryo develops, but may be reserved as perisperm.

In the ovule the ovum becomes the embryo, the integuments form the seed-coats, but the micropyle and funicle remain as at first. The stigma and style wither and fall. The ovule grows, as does the ovary or fruit-wall. Thus fruit is formed.

The process of fertilisation is preceded by pollination, the course of which has already been briefly outlined in the Introductory Volume. Cross-pollination resulting in cross-fertilisation is apparently the most successful in relation to the production of fertile and good seed.

The crossing of varieties is frequent in nature and is largely resorted to in horticulture. Crossing between different species or even genera, the latter rare, is hybridity. It is rare in nature,* but frequently

* But less so than has been thought.

accomplished artificially by artificial pollination, as in the case of varieties or forms. For a discussion of Mendelism and the principles of plant-breeding, the works cited in the Bibliography (vol. ii) should be consulted.

### 13. The Forms of Plants, and Adaptation to Environment, and Function.

One may either consider the forms of plants, taking into account the plant as a whole, or the forms of the separate parts of the plant or its organs.

Generally speaking the growth-form exhibited by each plant is an expression of its adaptation to the environment, to a very large extent. The influence of heredity and the trend of evolution, of course, in the first instance regulates such forms. But though a large number of plants of the same group exhibit the same type or habit, as the cushion habit in the Stonecrops, yet there are numerous orders in which different types of habit in the same genus are represented, as in the case of the Buttercups, where the yellow-flowered forms are land plants with an erect or creeping habit, broad leaves and short internodes, whilst the white-flowered types are aquatic plants, and have narrow leaves and often a streaming habit —with long internodes, and a different mode of nutrition. But all the Buttercups agree in certain characters which causes them to be placed in the group Ranunculaceæ. The differences that occur

between this group and other orders are mainly structural, in the relation of the parts of the flower.

We may thus say that the vegetative parts of plants are more easily altered by the environment than are those structures concerned with reproduction, and possessed of some inherent character not influenced by environment (at least not so easily) which is transmitted through the germ-plasm. Heredity is stronger than adaptations of the soma to the environment.

There are several types of habit or growth form. In the early days of botany these were limited to trees, shrubs and herbs, and such forms were used in classification. But we now know that trees may belong to a number of different orders which have the tree habit in common.

It is true that we may recognise many species by their habit at a distance, *e.g.* the heaths, grasses, etc., each having the heath or the grass habit, as trees have the tree habit. But many other plants have the heath or the grass habit which do not belong to the heath order or the grass order.

Amongst flowering plants there are what are called heterotrophic plants which include saprophytes and parasites that live upon decaying vegetable matter and are not green, as the Bird's Nest, and parasites that live upon other plants, as Broomrape. These also are not green plants.

There are also lianes which rely upon other plants for growth support, and are generally climbers. Such

are twining plants, as Dodder, root-climbers, as Ivy, and there are also hook-climbers, tendril-bearers, and leaf-climbers.

Amongst the autonomous plants are renascent herbaceous plants including those with tufted rhizomes, as Columbine, or crown formers, mat-geophytes with tubers, bulbs, etc., *e.g.* Crocus, travelling geophytes with spreading rhizomes, etc., as sedges. Rosette plants form a rosette of radical leaves, as the Plantain. There are also creeping plants with rooting stolons as many heath plants, *e.g.* Whortleberry.

Plants with erect perennial shoots include cushion plants such as Stonecrops ; and there are other types such as undershrubs, *e.g.* bramble, soft-stemmed plants, *e.g.* Lords-and-Ladies, succulents, as Sun Spurge, woody plants, *e.g.* canopy plants, trees, shrubs and dwarf shrubs.

The form of the different parts of plants is largely due to adaptation to function or to factors of environment.*

Roots serve for absorption and are adapted to this end. Their forms vary according to the soil or the water content. Roots serve also as a means of attachment.† There is a primary root and a secondary root. The latter are lateral, and produce tertiary

* Functional needs, however, also demand variation in internal structure.

† And are modified, therefore, to meet the requirements of each type of habitat. Terrestrial and aquatic plants differ markedly for this reason in form as in function.

roots. The whole forms a root-system. The older roots are furthest from the tip, the youngest the nearest. Near the tip are the root-hairs used in osmosis.

In form roots may be tap roots growing continuously downwards, and becoming larger. When the roots are swollen and fleshy they are tuberous. Some roots are conical, some are napiform, or like the turnip, others are spindle-shaped or fusiform. The lateral roots may equal the primary root in size, and these are fibrous. Adventitious roots develop at the nodes of creeping stems, etc., and give rise to new plants.

Stems serve for support of the leaves and flowers, and internally for water conduction, etc. Stems differ in being herbaceous or woody, hence we get herbs, shrubs, and trees. The former possess some woody tissue, but it is less developed. Stems are erect, prostrate, climbing or underground according to the nature of the habitat.

The characteristics of climbing plants are described under Clematis in vol. ii. In twining plants the stems turn to the right or to the left. Stems, for protection or for adaptation to dry conditions, develop thorns and spines. These are altered shoots.

Stems may also grow underground in the form of rhizomes, suckers, tubers, corms, bulbs.

Stems may branch, the first axis or main axis giving rise to branches or secondary axes, and these in turn to tertiary axes. A stem which grows at

the apex continuously is indefinite and the branching is racemose. When a terminal bud flowers, and the axis ceases to grow, the stem is of definite growth and the branching is cymose.

The buds upon trees are arranged according to certain laws. In some the buds are opposite as in the Ash or Sycamore. In others they are alternate and arranged in two rows on opposite sides of the stem, or in five rows. In the third type the arrangement is spiral, as in the Birch and Oak, etc. Their form and arrangement are largely related to their need for protection in winter.

The buds are young shoots provided with scales, which protect the former in bud, and later fall or persist. The buds may be terminal, or lateral and axillary. The first leaves are scale-leaves in trees and shrubs. Some buds are without scales and are called naked buds. Buds may be leaf buds, flower buds, mixed buds (forming shoot, leaves and flowers) and fruit buds, or the two last.

The stem may be regarded as a primary axis or shoot with nodes or joints, at which points lateral structures occur (leaves), and the regions between are called internodes. The early shoot is unfolded from a bud. The tip of the bud is the growing point.

The leaves* serve as organs of nutrition or the media for photosynthesis. They are lateral appendages and may be of two kinds, foliage leaves and floral leaves. The perianth is derived from the lateral appen-

* *I. e.* foliage leaves.

dages. The gynœceum may be of the same origin as the stamens,* and carpels may develop into leaf-like structures, but are not so obviously foliar in origin, being axial or modifications of the main axis. Stamens are not developed at the nodes except hypogynous stamens, the carpels being also usually terminal.

A leaf consists of a blade or lamina and a stalk or petiole with a sheath below which may bear stipules or not. The sheath may encircle the stem. There may be no leafstalk. The blade varies in venation. Venation, which is usually reticulate in Dicotyledons, is parallel in Monocotyledons. The veins in the former may branch in a pinnate or palmate manner.

The leaf outline varies considerably and the leaf may be linear, lance-shaped, ovate, elliptical, kidney-shaped or heart-shaped, arrow-shaped, spoon-shaped, hastate, etc. The margin may be entire, toothed, scalloped, lobed, dissected. The leaves may be united below or clasp the stem or be narrow below. The leaf is simple when the lobes do not reach the midrib, compound if they do.

The surface of the leaf may be smooth or hairy. The tip may be acute, with a long point, or blunt, notched, sharply and bluntly pointed. Leaf structures not regarded as true foliage leaves and serving separate functions are cotyledons or seed-leaves, scales, bracts (glumes in Grasses, the spathe in Arum), bracteoles, floral leaves, leaf spines, leaf tendrils.

The arrangement of the leaves may be in a whorl

* Which are, perhaps, modified leaf-like structures

or ring around a stem or branch, usually at a node. The leaves may be opposite and when successive opposite leaves are at right angles they are decussate. They may be alternate and spiral. The amount of divergence in the leaves or phyllotaxy can be measured in terms of the circumference as a fraction, being $\frac{1}{2}$ in the Elm, where a spiral between two successive leaves winds round half the stem. When of two leaves this is indicated in the denominator of the fraction as, for example, $\frac{1}{2}$ or $\frac{2}{5}$, as in the Peach. The numerator expresses the number of turns. Numerous other types occur.

Leaves thus exhibit almost as much, if not more, diversity in form, arrangement, etc., as the flowers or floral leaves, but for other purposes. Some leaves are peculiarly modified to serve as pitchers, as in the Teasel, some serve as spring traps as in Dionæa, and for catching prey as in the Sundew. In other cases they exhibit sleep movements as in Woodsorrel, or respond to touch as in the Sensitive plant.

The leaves vary in size according to the strength of the stem, being large in trees, small in herbaceous plants.* They may be close together and overlap as in the Beech, or be distant as in Hazel. These facts are related to the procuring of the greatest amount of light and air for photosynthesis.†

* Though the reverse may be the case. Number, moreover, counts in the case of trees.

† The form and arrangement of leaves, in a mosaic, etc., and therefore the form of each, as well as the distribution of the veins, the form of outline, the structure of the petiole, and the existence of

The leaves may be arranged on the stems in layers or horizontally, allowing light to penetrate between as in the Lime. Or the leaves may grow out on long stalks at right angles, and in such cases they form a pattern or mosaic so that each leaf more or less faces the light. They are usually opposite, the lower leaves larger forming an outer ring, the inner smaller fitting in between. With these arrangements the best position for the stomata in trees is below, but when the leaves are pendent as in the Aspen there are stomata both sides. In some plants they are on both sides, especially where, as in grasses and other plants, the leaves are erect, when the leaves are generally narrow and linear, or like those of aquatic plants. In hot countries and on dry soils the leaves are reduced in area and otherwise adapted to physiological needs.

Leaves may be evergreen or deciduous. In the former they are glossy and smooth, so that snow does not cling to them and cause the boughs to snap. If long-lived they are leathery, a protection against animals. In deciduous trees the leaves and stalks are separated from the stem or twig by a corky layer, which protects the leaf scar, and the leaf fall is coincident with the adaptation of the tree to dry conditions or rather physiological drought of winter cold.

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accessory devices, as pitcher leaves, are all also related to the conducting of water to the root-hairs, either to the centre or away from it.

Spines serve the double function of protection against animals and drought. Hairs on leaves are developed also as a protection against animals, as a protection to the flower to prevent the honey being stolen by creeping insects, and also to protect the stomata from being clogged, and so causing a bar to transpiration. Some hairs are glandular, and serve to excrete poisonous materials, and act again as a protection as in the Nettle.

Reference has already been made to the adaptations of leaves to shade or sun, and to an aquatic habit. Herbaceous plants, with narrow, much dissected leaves, are more exposed to air than other plants, which may account for the prevalence of such leaves or to the need for light, as they are often close in habit.

The forms of leaves are again adapted to their arrangement in the bud. The characteristics of the remaining types of structure, the floral leaves and fruits and seeds, have been described to some extent in the Introductory Volume, and need not be mentioned here. The main functions of the flower are pollination and effective fertilisation, that of fruits and seeds effective dispersal preparatory to germination and race progression.

## 14. The Structure of Plants, or Adaptations to Function.

The structure of a plant, unlike that or its form, cannot so well as the forms of plants be considered in relation to the plant as a whole, but organ by

organ. As a rule we may say that structure is intimately correlated with function. And since unction is expressed in structure it is more closely connected with the specific characters. The latter are preserved by heredity, and their limits defined by the evolution of the species. Any adaptations that may result in adjustment to the environment are less permanent.

In a word, the more plastic elements of the plant are those that are related to variation in form, and in these cases, more especially to the vegetative organs of a plant, rather than to the reproductive organs. The external characters, or form, as expressed in the visible anatomy of the plant, thus respond to environment and vary more than the more generalised parts (which make up the internal anatomy, the internal characters or structure), which respond to the ordinary processes of evolution, or to the inherent tendency to vary, which is less marked. But there is, of course, a reaction between each, and the one influences the other, to a greater or less extent.

The modifications which may arise in the internal anatomy or histological structures are thus expressions of the adaptation of each structure to its needs, and vary along the lines laid down by the evolutionary history of the species.*

* The adaptations due to environment and functional requirements which find expression in plant form are thus less distinctive, though often more apparent or obvious. The internal structural adaptations are perhaps less variable comparatively speaking than the external adaptations expressed in the specific form of plants viewed as a whole.

In each genus there are certain main characters, common to all the species, which are an indication of the retention of the structures evoked under natural selection as best suited to the needs of the plant, whilst the divergent characters of the different species are a result of the particular adjustment of the species to internal or external factors.

It is thus possible to take as typical of the structure of any organ of different plants that of any particular species. Unlike the forms of the organs of different species the structure remains largely the same for a genus or larger group.

The structure of a root is thus simpler than that of a stem, and the outer layers of tissue are especially modified to serve the purpose of osmosis where no cuticle is formed. It is possible, however, to recognise the difference between a section of a root and that of a stem. The structure of a root, as that of a stem and a leaf, has already been briefly described, and it is not within the scope of this work to enter into details as to the minute anatomy of plant structures.

Roots of Dicotyledons and Monocotyledons, however, differ in the absence of pith in the former. The first elements of xylem in young roots are on the outside, in stems on the inside. Later they are between the xylem and other elements. Wood and bast are not associated as in the stem but alternate till the cambial zone is developed. The number of strands may be two, three, or more,

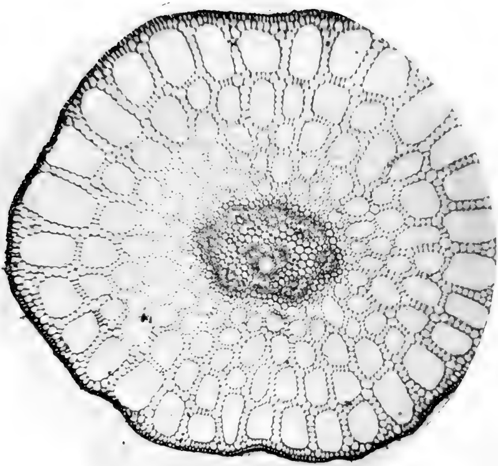


FIG. 9.—STRUCTURE OF A MONOCOTYLEDONOUS STEM, PONDWEED (*Potamogeton natans*).

*C. R. Mapp, photo-micro.* *See page* 33.

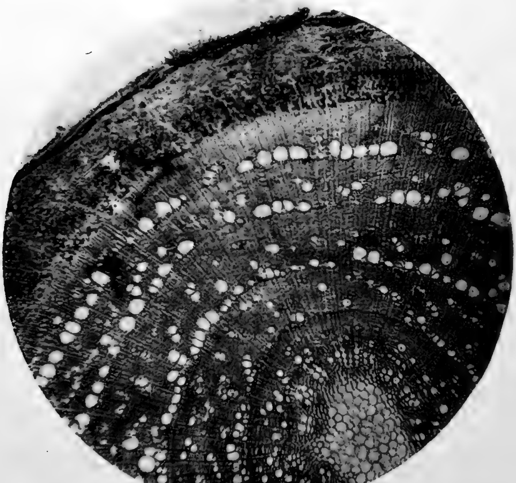


FIG. 10.—STRUCTURE OF A DICOTYLEDONOUS STEM, TRANSVERSE SECTION OF ELM (*Ulmus campestris*).

*C. R. Mapp, photo-micro.* *See page* 33.

and this is important in distinguishing different types.

In the stem the structures are different in the two groups Dicotyledons and Monocotyledons, as has been pointed out in the Introductory Volume. The former were called exogens, the latter endogens. In the Monocotyledons (see Fig. 9) there is no continuous ring of wood and bast, but they are scattered in the ground tissue. There is not usually a distinct pith, and the cortex is thin.

In Dicotyledons herbaceous plants have a less well-developed woody layer (see Fig. 10), though it resembles in the main that of young trees. The latter have the power to increase the thickness of the wood by secondary tissues, supplied by the activity of the cambium, whose initial cells divide up. The secondary tissue resembles the primary wood, etc., but the vessels and tracheids in the former have bordered pits and reticulate markings, and are not thickened with spiral or annular rings.

The modifications in structure of the stem are correlated with the amount and mode of branching, the need for support and the mode of increase in thickness. The tissues themselves are built up with regard to the carriage of water with salts in solution, or nutrient substances up or down the stem, and the direction and distribution of these is variously achieved by different contrivances for their effective circulation.

Leaf structure, like that of stem structure, varies

in Dicotyledons and Monocotyledons, the veins in the former being usually netted, in the latter parallel, with some exceptions. But in the latter there are intermediate veins connecting the parallel main branches.

The structure of the vascular bundles of the leaf is similar to that of the root and stem, but the arrangements of the other tissues are different to serve the purposes of photosynthesis, transpiration, and respiration.

The vascular bundles in the leaf are closed. The wood lies nearer the upper surface, the bast nearer the lower surface. The smaller strands have only spiral tracheids, which continue to the tip of the leaf.

The form of the stomata and their distribution varies for each type of plant, and in special types of plants, as aquatic plants, they are modified in relation to the environment. The general structure of the leaf has already been described. In more cases than in those of the root and the stem, and more markedly, the leaf is adapted structurally to the demands of the habitat.

Also it must not be forgotten that the floral leaves are specialised foliage leaves, serving a special purpose. The structure of the flower affords differences of form which are used as a basis for classification. The internal structure of stamens and carpels is more or less entirely connected with reproduction. The various adaptations of flowers to insects, wind, etc., have doubtless brought about not only their difference in form and colour (in the case of the

perianth), but also the need for subsequent fertilisation has evoked the variation in the pollen-grains and the ovules. The structural differences in the seed or fruit are correlated with the survival of the seed during the dormant period and its effective germination afterwards, hence the presence or absence of endosperm. By some the difference in the number of cotyledons is connected with a difference in habitat, Monocotyledons being considered as adapted to aquatic conditions.

### 15. The Natural History of the Plant.

Properly the term Natural History is best used to denote the study of Biology or life, and Geology, or that of the earth, including in the last mineralogy, petrology, or the study of minerals and rocks.

But the term has been applied in a more restricted sense to the study of the life-history of living things. A better word is bionomics, as it implies that the study is that of the activities and behaviour of a living organism.

This study applies alike to plants and animals. In the case of plants it is necessary to start from the commencement of the visible stages in the plant's development. This is seen in the germination of the seed. The various stages which it goes through in bursting from the seed-coat, and the penetration of the soil by the radicle, with the later emergence

of the cotyledons and the plumule, the elongation of the hypocotyl or the epicotyl as the seedling gradually merges into a green plant independent of the reserves stored up in the seed, all these constitute phases in the plant's life-history.

Unfortunately the study of the plant in this stage has been somewhat restricted to the physiological side of germination. There are, however, in addition to this aspect, which must not be omitted, of course, others. It is only possible to indicate in a summary some of these, and this applies to all the other parts of the introduction.

The writer merely wishes to indicate the main points or processes involved, without describing them at this stage in detail. It has been his aim rather to indicate the place of each process, etc., in the whole study of botany, and the relative importance of each or their bearing upon the others.

In regard to seeds and germination, then, apart from the actual process, there are questions of interest, such as the necessary conditions for germination, the soil-characters, water content, density, etc. When a seed is dispersed to a distance it is trying an experiment, as it were, in germinating in its particular station. Some conditions might suit it better than others. The length of time required in germination, the period of germination, the character of the cotyledons, their length of persistence and characters are points worthy of study in this connection. The amount of heat required

for germination and the resistance of the seed to cold in different species may afford interesting results.

When the early stages of germination are concluded the plant is marked out into definite regions of root, stem, and leaves; and later the flower develops, to be followed by the fruit.

The root and its rootlets adapt themselves to the character of the surroundings, and in these various ways and means of adjusting their organs to meet certain conditions there are many interesting principles involved. The way in which the root serves its purpose of acting as an organ of attachment affords scope for interesting observations. It will vary in wet and in dry situations. Aquatic plants differ markedly from land plants in this respect. The modifications required in the case of crevice plants and those plants that live on walls in the crevices of stones or bricks may be contrasted with the roots of such plants as parasites on grasses, etc., or saprophytes. The tubercles developed on Leguminosæ and other plants such as the Alder, which have bacteria in them, and the relation of these to the soil and the plant, are interesting from the economic standpoint. The study of the modifications in the roots of some wild plants cultivated as vegetables is also of the same value.

The relationship of the root to the water in the soil, to the salts in solution, and air in the soil, and the utilisation of all these factors in its life-history forms part of the natural history of the plant.

So far as the stem is concerned the chief significance to the plant is the manner in which it exposes the rest of the organs, the leaves, flowers, and fruit to the agencies which specially affect each, the air and light in the first case, insects, etc., in the two latter.

The stem also differs markedly in its duration, extent of wood formation, the arrangement of the branches, and its coverings. Some stems are protected from animals by thorns or prickles, *e.g.* Holly, Hawthorn. The glands serve also for excretion. The stiff hairs form a *chevaux de frise* against the ascent of creeping insects. The stems of plants are also adapted in relation to the distribution of the leaves, and the character of the leafstalk to the carriage of water to the root, or to the exterior of the plant, where the branches and leaves form a close canopy and water drips around the circle so formed and at a distance from the primary root or axis.

The chief physiological function of the leaf is the securing of food-materials for nutrition, from the atmosphere, by photosynthesis or assimilation. The leaves also take part in the processes of respiration and transpiration. They are variously adapted for these purposes in different types of plants, *e.g.* in water plants as opposed to land plants, or according as the habitat requires of the plant different modes of response to the conditions of existence.

The arrangement of the leaves upon the stem is connected with these functions. They are arranged,

as a rule, so that they may receive as much light as possible, being generally horizontal, sometimes broad, sometimes narrow. The factor of shade causes plants to be modified, especially in leaf form, to the light conditions.

Drought, physical or physiological, is another factor which necessitates modifications in the form of the leaf, the leaves of plants exposed to such conditions being usually narrow and often rolled up.

Cold or heat cause similar modifications to those of drought, especially in regard to root absorption, and this in turn affects the leaves.

The supply of water to the roots from rain is also responsible for the different arrangement of the leaves in different plants, and these arrangements are also connected with the adaptations of the stem to the same end, hence the mosaic patterns of leaves, the channelled leafstalks, and hollow upper side of the leaf with impressed veins, etc. The habit of the plant, form and arrangement of the stem-leaves are all connected with this factor of water-distribution. In leaves there is also need to protect the water they contain from evaporating, and the stomata from being clogged by water. The surface may be smooth or hairy.

Leaves also require protection from browsing animals and are sometimes spiny or prickly as in the Sea Holly, or covered with stiff hairs as in the Woundwort, etc., or with stinging hairs as in the Nettle, or they may be leathery, fleshy, etc.

In order to resist cold, etc., the leaves may close up at night or in cold weather, as in the Woodsorrel.

The life-history of the leaf also takes into account the mode of arrangement of the leaves in bud, and their mode of opening or vernation. The protection of these buds by stipules also is a matter of extreme interest. The leaf-fall of deciduous plants is another subject for study in this connection. In the case of evergreen trees the surface of the leaves varies, but may be connected with the prevention of an accumulation of snow upon the upper surface in winter.

In the case of the floral leaves and the resulting fruits and seeds developed from the ovules of the pistil, the adaptations which are called forth under the varying conditions of existence are largely concerned with the future generation which they play such a great part in producing. Since these conditions are not fulfilled without the intervention of agencies other than those of the plant itself, the life-history of the flower is especially interesting, in that it has to do with such factors as water, wind, insects, and other agencies. This applies equally to pollination and to the dispersal of fruit or seed after fertilisation.

The unfolding of the flower bud or æstivation is similar in kind to that of the unfolding of the leaf-bud. As a rule the æstivation of all flower buds on one plant is the same. The mode of æstivation of the flower buds varies in different types of plants, and though they usually overlap or are twisted the parts may be sometimes open.

The character of the outer perianth is a point of interest in the life-history of the flower. Usually the calyx serves as a protection or as a support for the corolla. The former, as a rule, is not brilliantly coloured, except in many Monocotyledons and some Dicotyledons. It may even be absent, and the flowers are then usually wind-pollinated. The calyx may also serve as a means of dispersal of the fruit when it is persistent, but frequently it falls, like the petals, when the important function of pollination has been performed. It may also serve as a protection or covering for the fruit or seeds. The arrangement of the sepals is also important in classification. The number of parts or the absence of sepals in this case again serves as a basis for arrangement. Sepals may be either reduced in number or suppressed. They may also become fused with other parts, and may be irregular as in the case of the corolla.

The suppression or reduction of the calyx in such groups as the Compositæ would seem to be connected with a general economy of parts for the closer arrangement and greater production of essential parts, for seed formation.

The corolla is generally brightly coloured when not white, when, however, it is equally conspicuous, especially at night. The character of the corolla in relation to insects especially, and the particular arrangements of the flower in relation to pollination are perhaps the most interesting features in the life-history of the plant. Being visible features they are

also, like the visits of insects, etc., more readily observed by the beginner, and therefore useful factors in arousing that interest and sustained observation, and the asking of questions as to the why and the wherefore of such phenomena, which is so necessary before entering upon the more serious phase of study.

The colour of flowers in general is an interesting subject, and is in the main connected with pollination. The colours are due to pigments in the cells, akin to those of the leaves, etc.

There are a few main types of colour which distinguish flowers, yellowish-green, yellow, red, white, blue. Red, yellow, blue or white are the commonest.

In addition to the colour of the flower there are the markings, such as spots. There are also lines, frequently converging to the base of the corolla, which are honey-guides to direct the insect, in entomophilous flowers, to the honey. White is the predominant colour in flowers that bloom at night, and in aquatic floating plants, as being the most conspicuous against the dark background of the water in the last case.

Some flowers are versicolorous and turn colour. Some last long, some are fugaceous, or soon drop. In others the flowers soon fade. The time of flowering is an interesting phenomenon, and so is the duration of each flower. Both these are features that are connected with the season, the temperature, the soil, and the needs of the plant, or its adaptation in relation to insects.

When the flower opens is a feature which has given rise to much quaint folk-lore, and there are weather plants which are used to tell the time of the day.

The protection of the flowers after they are open is effected by bending over as in bell-like flowers, and is connected with the preservation of the pollen or honey from the rain or from insects. Some flowers are always pendulous, but others are erect at first, then drooping. Some sleep or close up during certain parts of the day when it is wet, or at night. Others close up to protect the flower from cold, as in the Daisy. When the flower has been pollinated, and the fruit is forming, a similar kind of movement occurs as in the case of flowers that droop to protect their honey or pollen. The petals of course also act together with the calyx, as a protection to the inner floral organs, the stamens and pistil.

The adaptation of the perianth to the pollination of the flower by insects, etc., is shown by the evolution of the flower from possibly apetalous types at first, through hypogynous types with distinct calyx, and corolla (or either distinct), through those in which the calyx is united or partly so (or with the corolla united or partly so, or with both conditions), to those in which the perianth is monosepalous or monopetalous or tubular. Whether this is the manner in which the orders of plants have evolved is not absolutely established, but this is the sequence in which, theoretically, they may have done so in relation to the

types of insects adapted to each, and their order of development or evolution.

The order in which each flower upon an inflorescence opens is another subject which demands a series of observations. In some cases the first flower to open is at the top, in others the lower flowers open first.

The occurrence of double flowers may be due to various causes. Frequently the stamens become petals. In others the petals become stamens. It is considered that the latter gave rise to the former.

The stamens exhibit a great deal of variety in number, form, and structure. They are generally in a ring around the centre of the flower, and lie in such a relation to the usually central stigma that pollen is brought to the stigma of the same flower, or can be transferred to that of another flower, either on the same plant, or on a different one by different agencies.

The stamens are not usually conspicuous. They are pollen-bearing, and in them we come a stage nearer to pollination preceding fertilisation, the latter the last function in the life cycle of the plant, before a fresh individual is dispersed and in due course enabled to germinate.

Interesting observations as regards the stamens may be made as to the time of opening, *i.e.* either before, at the same time as, or after, the stigma is ripe. Another feature is the way in which the anthers ripen. They may open towards or away

from the centre. The number and the form of the stamens is a matter of interest, and served Linnæus, in the case of their number, as a basis for his system of arrangement. The position of the stamens in relation to the receptacle or the ovary is important in a natural system of classification. The stamens may be united as in Leguminosæ, entirely so, or all but one may be united. They may be divided into two groups, long and short. Their arrangement in relation to the honey is important. The amount of pollen (and stamens) varies with the mode of pollination. In wind-pollinated flowers the pollen is more abundant and the stamens more numerous than in a typical insect-pollinated flower. The size of the pollen-grains varies, so do their form and surface characters. All these and many other points form interesting phases of each plant's life-history.

As has been said, the carpels or pistil are usually in the centre of the bisexual flower.

The pistil consists of an ovary, with one or more ovules within, with a style and stigma above. The position of the ovary in relation to the perianth is a matter of importance. So is the adherence or non-adherence of the ovary to the other parts of the flower. The ovary is sometimes free or apocarpous, as in *Ranunculus*, etc.

The number of chambers in the ovary may be few or many, as many as the carpels or not. The ovary may vary in its shape, as may the ovules.

As in the case of the stamens the mode of pollina-

tion is intimately connected with the character of the style and stigma, their position, the time of ripening of the latter, the absence or presence of the pistil in a flower. The surface and form of the stigma also vary, as do the number of stigmas and styles, these being most abundant in wind-pollinated flowers.

The mode and manner of fertilisation in each flower is a subject which has received relatively but little attention until within the past few years. It is an essentially interesting feature, and one which is much to the fore at present, especially in connection with the division of the chromosomes and the study of the evolution of plants by Mendelian or other principles. The last feature or fruit formation and the maturing of the seed is preliminary to the process of germination or the initial stage of a new generation.

The fruit or seed varies in number, form, size, surface markings, colour, texture, and other features. The size and weight is important in determining its dispersal and the nature of its struggle for existence. The appendages that some fruits and seeds exhibit, or the mechanisms the plants afford for dispersal, or their adaptation to dispersal by wind or water, etc., have been briefly described in the Introductory volume.

## 16. Classification.

A short history of the course of plant classification

has been given in the Introductory volume. For further information the reader is referred to Prof. Green's 'History of Botany' (Oxford University Press), and to 'Makers of British Botany,' Mrs. Arber's book on herbals, and other works. An admirable brochure is the 'History of Plant Classification,' or guide to the books and portraits in the Botanical Department of the British Museum (Natural History) that illustrate this subject by Dr. A. B. Rendle. These volumes and portraits are well worthy of a visit of inspection and study.

In the study of systematic botany, which is the same thing as classification or taxonomy, there must be necessarily some system of nomenclature and of description, in order that any arrangement of plants, which is the final end of taxonomy, may be rendered possible.

At first there was no such distinction between the scientific names of plants and the descriptions in Latin, and in Ray's time (seventeenth century) the plant was distinguished by a Latin sentence of several words. Gradually this was reduced to two words, as at present, by Linnæus, who invented, or rather brought into general use, the binomial system, as it is called.

The first Latin name stands for the genus, which is common to several species signified by the second Latin name. The unit of classification is thus the species.

*Species* is a term which denotes the group of

individuals which are essentially alike in more characters than one, or differ only in a small degree, and may be regarded as derived by evolution (or the derivation of later and more highly organised plants from earlier or less specialised types) from a common ancestor. The exact definition of a species in the case of plants is not easy to frame, because plants are more plastic or more liable to vary than animals, though even in the latter case, again, definitions as to specific differences or identities are not easy to adopt. If it is remembered, however, that terms are relative only, and that actual boundaries between two forms are liable to vary, the difficulties of nomenclature as to fixity of specific forms is somewhat diminished. We recognize that nomenclature is elastic, and is, therefore, progressive. The present state of our knowledge is capable of readjustment or improvement, and no boundaries are rigid.

We may thus admit that an original species may be connected with another which is essentially different in some more or less important character by the existence of other individuals, or grades of individuals, which we may call *varieties*. The endless types of individuals which link up two allied species, or groups of individuals, may be connected by such intermediates or varieties ; and the denoting of certain striking types by such terms as variety may help us to fix more accurately or more conveniently the degrees of relationship or difference between the extreme types. The variety, as a rule, therefore

differs from the species in a less degree than two allied species. It may also be differentiated by the fact that a true species usually breeds true to type from seed under cultivation, whilst a variety may or may not do so. It may, however, be propagated vegetatively and remain constant or not. If there be some main character which distinguishes a set of individuals from one another (but one presumably belonging to the same species), it may be regarded as a *subspecies*, when the character by which it is recognised is found to remain permanent through a series of generations. By some the term *race* is used in the same sense. When the character is less permanent the individual may be regarded as a *form*, and when it reverts to the type such a form exhibits reversion or atavism. *Sports* are impermanent forms, and may be abnormal variations due to injury or some other cause. Double flowers are of such a type, though they may be more permanent than such monstrous characters as the peloria state of the Snapdragon.

All these groups of individuals, species, varieties, forms, etc., may be arranged together in a *genus*, which includes a number of species (or sometimes only one) which differ singly in some one character (or more than one) from others. The genus, however, combines in its range plants which are all connected by some character or characters that distinguish them from another genus, and these are convenient groupings which help to show by a further stage the history of the group or the individual, or

its phylogeny. These differences of generic value in the case of flowering plants are generally of a higher type than those that distinguish species. They have to do with the floral structure as a rule, a factor which is used throughout the plant kingdom, or at least in the case of Phanerograms, in classifying plants according to their grades of relationship or main divisions.

Thus while the plants of the genus *Ranunculus* agree with those of the genus *Adonis* in possessing carpels which are arranged in a round or oblong head, the former differs from the latter in having a scale at the base of the petals. The fact that the flowers of *Adonis* are red in the British species distinguishes the genus in this case from those of plants of the genus *Ranunculus*, where the flowers are yellow or white. These two genera are also distinguished (with others) from a second group of plants in the same family (order), by the fact that the carpels are here one-seeded, whereas in Larkspur, for instance, the carpels are many-seeded.

Several genera are collected together on a similar basis and arranged in a *family*, or *natural order* as these are frequently termed, because they each agree in some important character, and may be distinguished from all other families or natural orders in this respect. The order Ranunculaceæ includes genera in which the plants have generally the stamens distinct and hypogynous, and in which the carpels are also distinct. From the Rosaceæ, with which they agree in having the carpels free and

numerous stamens, they are distinguished by the different position of the stamens in the latter group.

A more general and common character (or characters) is employed to arrange such orders into *classes*. Thus, whilst in Ranunculaceæ and Alismaceæ the stamens are inserted upon the receptacle, the former includes species in which the embryo is provided with two cotyledons, and therefore the plants are Dicotyledons, whereas in the latter there is but one which sheaths the plumule at first, and the order is monocotyledonous. In the Ranunculaceæ it is true there are several species which have but one cotyledon, as in *R. Ficaria*, this being a character connected by some with an adaptation to aquatic conditions. But a further distinction between the two classes lies in the number of the parts of the flower, five or four in the former, three or a multiple of three in the latter.*

Classes may be divided up into *sub-classes*. So also by the prefix of the same syllable minor divisions may be made of other groupings. The class Dicotyledons is sub-divided thus into four sub-classes by Bentham and Hooker, into two by Engler and Prantl. In the former case we have Thalamifloræ, Calycifloræ, Gamopetalæ, and Apetalæ. The characters of these sub-classes are given in the descriptive part of the Introductory Volume and the two other volumes.

The classes are grouped together as *phyla*, lines of descent or *tribes*, and of the two phyla the flowering

* This double distinction apart from others, as the Venation, serves to show the classification is more or less natural.

plants belong to the Phanerogams or Spermatophytes, being seed-plants. These are again divided into *subphyla*, as (1) Gymnosperms, or seed plants with naked ovules, and (2) Angiosperms with ovules enclosed in an ovary or fruit-wall.

In the selection of the characters that serve to mark off plants into groups, or their arrangement according to the affinities which they may be assumed to possess in common with others, distinction must be made between a purely artificial system and a natural system. By the former method the earlier botanists were led to arrange plants at first into such groups as Trees, Shrubs, and Herbs. These divisions are based entirely upon habit. All trees do not belong to the same natural order and although a large proportion are Angiospermous Flowering plants, some are not, such as Gymnosperms, *e.g.* Yew, Pine, etc. Whilst, again, many are dicotyledonous, some *e.g.* Palms are monocotyledonous. In the case of Dicotyledons again whilst a large number are members of the Amentiferæ there are many other groups of trees, as those of the Lime and the Ash.

The same may be said of shrubs and herbs. Indeed, herbs include a large proportion of flowering plants of the most widely divergent groups.

Another mode of division of plants according to their use, suggested by L'Obel and adopted by Gerard, was of no higher value.

Linnæus made use of the number of stamens to group plants. This, whilst an advance upon previous

methods as a means of arrangement and a mode of of subdivision, was no improvement upon earlier systems from the natural standpoint. All these systems were artificial. They hit upon some *one* factor which was applied to all groups of plants, such as the tree habit.

A truly natural classification is necessarily based upon more than one character and takes into account the essential differences.

The vegetative structure is more variable than the floral structure. Hence the latter is most valuable as a basis for classification. The natural arrangement was more or less anticipated by Ray, who recognised the divisions of flowering plants into Dicotyledons and Monocotyledons.

De Candolle, improving Linnæus's later attempts to found a Natural System, and adopting Jussieu's divisions Apetalæ, Monopetalæ, Polypetalæ, laid the foundations of Bentham and Hooker's system. Before the latter was elaborated Brown discovered the distinction between Gymnosperms and Angiosperms. The later classifications have been largely based upon the modifications of the whole floral structure in relation to the visits of insects and pollination, and though not formed primarily as a result of a study of the latter, researches carried out by Sprengel and others, and later by Müller, have shown that these divisions are related to the adaptation of the flower to entomophily.

Botanical description, as distinct from nomen-

clature, includes the correct diagnosis of the characters that distinguish a species, genus, or other grade of affinity. It is customary to describe new species to-day in Latin, as this language makes for conciseness and allows one a better chance of describing minute differences than does English. The word hairy, for instance, can be made capable of several degrees of meaning in Latin, whereas in English it is capable of but one without a qualifying adjective.

Descriptions must be framed upon a proper system. The parts described should be taken in the natural order, starting from the earliest or lowest organs, and proceeding upwards. There is a special terminology or system of description for each of the parts of the main different systems of organs, such as root, stem, leaves, flowers, fruit, or seed, and the terminology of the one will not as a rule suit that of the others.

The form of the description also requires careful study, punctuation in particular demanding special attention, as upon this depends the separation of the description into its proper parts depending upon the morphological sequence.

## 17. Evolution.

The types of plants considered on a basis of structure and form are not all of the same degree of development. There are lower types and higher types. It is natural to suppose that the latter have been derived from the former. It is not, however,

probable that the chain of plant-forms is a linear series. Some of the lower types have become more specialised and have then diverged or branched off from others which have given rise to a still higher group, and from these again other groups have diverged and proceeded no further, whilst in other directions their common ancestors have given rise in different directions to higher forms in a progressive series. The relationship between the different groups of plants may thus be compared with the ramifications of the branches of a tree.

The origin of the higher plants from the Bryophytes,* following Campbell,† is shown on page 56. In the Bryophytes archegonia and antheridia are developed. These organs are found on the gametophyte or sexual generation, as in the higher Cryptogams and Phanerogams.

A consideration of such a scheme or phylogenetic tree, which graphically indicates the probable history of each group, shows that there are several features in the evolution of plants that regulate their history in time and space.

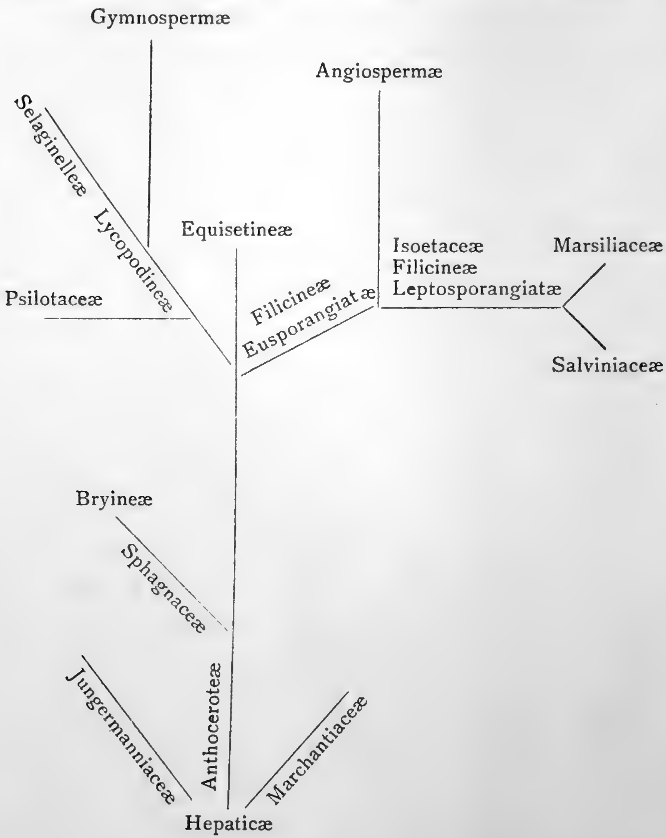
In the first place the branches of this tree show that in the main groups of plants there has been considerable variation in the original forms since they were first produced, otherwise we should have no divergence.

If one considers the vast number of individuals

* On this point the researches of Dr. F. Cavers should be consulted.

† *Cf.* also Bessey, Moss, Tansley, Wernham, and others.

produced by a single plant, and the varying conditions to which they are exposed, this is a natural




conclusion. Each plant responds to the stimuli that its habitat provides, and as the habitat and the other factors such as soil and the variable degrees of heat, light, moisture, etc., are variable it is not difficult to

comprehend that in each different set of circumstances the individual will respond differently, and that this response will have an effect upon the structure or form of the individual. As these modifications accumulate the plant will differ considerably from the original type. The response of the internal factors to the external factors is a measure of the amount of variability.

The organs of the plant will thus become altered as they have to perform different functions. Even if the conditions are more or less the same the individuals will tend to vary, owing to the intense competition. Some will die, others will survive. The plants that exhibit some character which is of advantage to them in such conditions will persist or survive, the rest will succumb. Such a character by natural selection will then be developed, and the variation or adaptation which is of use will be transmitted to succeeding generations and become fixed. Useless adaptations will be rejected. Variations may be produced by artificial selection as in horticulture.

When any character becomes fixed it is hereditary. Heredity is opposed to variation by which the plant tends to vary from its ancestral type. Moreover, each individual of a species tends to preserve in the main the characters of the parent, and this is due to the influence of heredity. Variation may be direct when plants of different type are crossed; when the variation is due to the influence of the environment

it is indirect, when it results from competition, direct when due to soil or climatic variations, etc. The characters of the parent are transmitted to the offspring by the principle of heredity or the adherence to type, but in all plants there is an inherent tendency to vary, or a potential power to respond to the varying conditions of existence.

Variation may be continuous when there are a few extreme intermediates on both sides of which the variations continue to decrease, or when they tend to disappear in identity with the type. When, however, such a chain of variations exhibits several points at which variations tend to become more marked they are discontinuous. Such variations are sports, or monstrosities. They may also be regarded as mutations where small differences tend to become marked, and by degrees these incipient forms give rise to new individuals. In continuous variations there will be varieties and intermediates which connect more marked and stable species. In discontinuous variations new species may arise more quickly.*

The adaptations to the environment which plants exhibit in response to the changes in, or effects of, the environment are marked in the different growth forms that may be found to characterise different types of habitat. The forms of Heaths and other plants that

* The views of Bateson as unfolded in his presidential address, British Association (1914), should be carefully studied. They suggest a revision of our views as to variation (not evolution) on the lines laid down by Darwin.

grow on heaths are an expression of the adaptation of the different plants that inhabit them. Not all the floristic elements of a heath are of the same order, however, nor are the different organs of each diverse plant-form found on a heath of the same type, but in the main the type of adaptation in each case is more or less similar in the nature of the work the particular organ is called upon to perform. The diversity of the plant types thus evokes a difference of response according as the ancestral type of each varies from the rest of the components of a heath formation.

By comparing the forms of the same organs in allied plants, or by comparative anatomy, or morphology, one may determine the probable history of such forms, or how one form has been derived from another, or the sequence of such changes. Similar organs are homologous, and are more easily distinguished in the more recent forms than in the earlier ones.

In the case of early ancestral forms there are generalised types which combine the characters assumed by several later types, and from which the latter may be derived.

One set of organs may be modified, as leaves into spines, etc. These facts also illustrate the sequence of the evolution of one set of organs from another, or the development of each form of organ.

Thus the floral leaves may be regarded as perhaps derived from the foliage leaves. The history of the individual, or the study of ontology, helps to elucidate

this by means of embryology. For the history of the individual repeats the history of the race. This is the principle of recapitulation which has largely been deduced primarily from a study of extinct or fossil types.

A study of the early stages of plants also shows the real significance of certain organs, which becomes less marked in the adult. When such organs obscure the affinity of a plant, the early seedling stages may give a clue to the origin, as in the case of the early leaves of the Furze, or Barberry.

Some plants, however, owing to various causes, tend to exhibit more than one type of structure in the case of one or more organs, or dimorphism. The leaves of some plants are polymorphic. Many different groups of plants exhibit outwardly similar structures, which in reality are not homologous, and the plants are really derived from widely different ancestors. Such organs are of multiple origin. It is possible to recognise that an organ of a species in one group is homologous with that of an organ of a species in another group. In the same group allied species possess organs that may be regarded as homologous. But in the former case it may not be due to derivation of the types from a common ancestor.

If the evidence of palæontology, or in this special case of palæobotany, be taken into consideration, it is found, as in the case of morphology and embryology, to bear witness to evolution in the past.

Present day forms are in fact only the last stages

in the chain of progressive evolution. There were originally only lowly types of plants of the order which we now regard as the lowest in point of development. These were Algae, which are found in the early Palæozoic rocks. Later there appeared vascular Cryptogams, Ferns, Lycopods, etc., Horsetail-like types, and an extinct type of Gymnosperm allied to Cycads and Ginkgo.

In the Carboniferous, higher types of these and arborescent Lycopods appeared, and many of the so-called fern types had the characters of seed-plants in possessing, in place of the sori of the fern, seedlike fructifications. They had also some Cycad-like characters. Some of the Clubmosses even had the same seedlike habit, *e. g. Lepidocarpon.*

Later Cycads, Conifers, Ginkgo, and a peculiar type *Bennettites* appeared with primitive Angiospermous characters, which lead on to the ancestors of the Angiosperm.

Monocotyledons and Dicotyledons appear much later in the early Cretaceous, and onward in the Tertiary, but the connecting links between the Gymnosperms are not forthcoming, though theoretically a type has been hypothecated which answers to the Proangiosperm connecting the *Bennettites* type with the modern Angiosperms. Thus, in this brief sketch of the march of plant-life in the past, we see that there were phases of life which were characterised by lower and lower types, as the earlier rocks are successively examined. This corresponds to the

RANGE IN TIME OF PLANTS.

| Thickness. | Period. | Algæ. | Fungi. | Lichenes. | Hepaticæ. | Musci. | Filices. | Equisetales. | Lycopods, etc. | Cordaitales. | Pterido-spermia. | Cycadales. | Coniferæ. | Ginkgoales. | Monocoty-ledons. | Dicoty-ledons. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Unknown | Pre-Cambrian . . | (?) | | | | | | | | | | | | | | | Azoic |
| 12,000 | Cambrian . . . | × | | | | | | | | | | | | | | | Palæozoic. |
| 22,000 | Silurian . . . | × | | | | | | | (?) | | | | | | | | |
| 4,000 | Devonian . . . | × | | | | | × | × | × | × | | | | | | | |
| — | Old Red Sandstone . | | | | | | × | × | × | × | × | | | | | | |
| 12,000 | Carboniferous . . | × | × | | | × | × | × | × | × | × | | × | | | | |
| 1,500 | Permian . . . | | × | | | | × | × | × | × | × | × | × | | | | |
| 3,000 | Triassic . . . | × | | | | | × | × | × | (?) | (?) | × | × | × | | | Meso-zoic |
| 5,000 | Jurassic . . . | × | | | × | × | × | × | × | | | × | × | × | | | |
| 2,500 | Cretaceous . . . | × | | | × | | × | × | × | | | × | × | × | × | × | |
| — | Eocene . . . | × | × | | | | × | | | | | × | × | × | × | × | Caino-zoic |
| — | Oligocene . . . | × | × | | × | | × | | | | | | × | | × | × | |
| 1,500 | Miocene . . . | × | | | | × | × | | | | | | × | × | × | × | |
| — | Pliocene . . . | | | | | × | × | × | × | | | | × | | × | × | |
| — | Pleistocene . . | × | × | × | × | × | × | × | × | | | | × | | × | × | |
| — | Holocene . . . | × | × | × | × | × | × | × | × | | | × | × | × | × | × | |

recognised history or classification of present-day plants, according to their supposed affinity or order of development.

The table on page 62 shows the distribution of plant types in the rocks.

### 18. Geographical Distribution.

Another argument for the evolution of plants from the lower forms to the higher types is derived from the facts of geographical distribution. According to this view plants have developed in different regions or centres and have spread over the globe by various agencies. Some plants, which are now of universal occurrence, exhibit similar characteristics in all regions, or variations according to the diversity of their habitat. In other cases the plants that are characteristic of certain regions, such as the Palms, for instance, have been restricted to those regions owing to limitations of climate or other barriers, such as mountains, deserts, the existence of seas, oceans, or because they have been evolved in insular regions and have been cut off from other terrestrial regions. In the last case, however, the fruits or seeds of plants have been dispersed by currents, and have germinated on islands and become established there. Island floras may, when of oceanic type, be specialised, or, when continental, resemble the flora of the mainland.

The existence of mountains may in some cases be

favourable to the extension of range of a species, plants tending to travel along such barriers and to penetrate new regions.

When a flora is isolated it may retain primitive characters and form a characteristic type of vegetation.

When widely diffused a flora may exhibit great range of variation, in so much that the original centre of dispersal may become obscured, and different centres of diffusion may in the same circumstances tend to intermingle and to become fused.

A main cause of the demarcation of vegetation into special regions is the influence of climate. Owing to the division of the earth into zones of temperature, cold, temperate, and hot regions, we have different types of flora in each.

The Arctic flora is largely made up of lowly types of cryptogams, such as mosses and lichens, and dwarf hardier trees, and shrubs, sedges, willows, saxifrages, Primulas, etc. When the flora occupies the heights of mountains and is akin to the Arctic flora it is called an Alpine flora, and many Alpine plants are Arctic types, which, brought south in a glacial phase, have become stranded on hills and have retreated as the temperature was raised with the retreat of the ice.

Other types of plants may have been forced to retreat to lofty hills owing to the intense competition in the lowlands.

The Temperate zone is divided into two sub-zones, the Cool Temperate and the Warm Temperate. The former lies between the latter and the Arctic zone, and the average temperature varies from 40 to 60° F. It is characterised by the predominance of deciduous forest trees or rarely evergreens. The bulk of the herbaceous plants are perennials. Many of the trees are tropophytes.

The Warm Temperate zone is equivalent to the Subtropical zone, and the temperature is much higher than in the Cool Temperate zone. The vegetation consists of shrubs, grasses, cereals, cotton, a few palms. Many plants are annuals or biennials. Many of the southern British plants are members of the floras of this zone, as the northern types are derived from the Arctic and Cool Temperate zones. There are numerous rainless areas and deserts in this area, but they are not so frequent as in the Tropics.

In the Tropical zone the temperature is highest, as this zone lies on either side of the equator, where the sun is vertical at mid-day and the air is moist and the sun's rays intense. This is the region of Palms, Screw Pines, Tree Ferns, Bamboos, and many epiphytes. It is in this region that jungles occur and rain is excessive at certain seasons. Growth is luxuriant. There is no winter, and the trees are not deciduous but evergreen. In some areas there are extensive deserts and the plants are adapted to dry conditions, as Euphorbias, Cacti, Aloe, etc.

The present-day distribution of plants is, of course, also dependent upon the constitution of the floras of the past. These have undergone change owing to the alteration in the distribution of land and water, and the alterations of climate. The following table gives a summary of the character of the conditions of surface whether land or sea in past ages, and the nature of the climate so far as we can approximately consider it to have been constant at any one period.

The table on page 69 shows the probable area of the different geological formations and their representation in one or more of the main zones of vegetation according to climate. The vegetation of lofty hills in the tropics is a repetition of the vegetation of the lowlands as we travel from the equator to the poles, showing that altitude as well as climate is of importance in determining the distribution of plants.

### 19. Plant Formations.

The study of systematic botany is concerned with the study of the *species*, which in floristic plant geography therefore constitutes the unit. Plant geography, however, also embraces ecology, or the study of the habitats of plants, the *communities* formed by plants, and the various other problems relating to the connection between plants and their environment, studies which are physiological in part as well as morphological.

The unit in ecology is then the particular type of

## GEOLOGICAL CLIMATES (AND RELATION OF LAND TO THE SEA).

| System. | Nature or origin of sediment and flora. | Climate. |
|---|---|---|
| Post-glacial . . | Recent *alluvium*, *river-gravels*, *peat moss* (man, and lake-dwellings, etc.) | From cold to gradually milder conditions as at present. |
| Pleistocene or Glacial | *Cave-deposits*, *raised beaches*, *boulder-clays*, *gravels*, *sands*, *morainic deposits* (Arctic plants) | Periods of intense glacial conditions with inter-glacial milder periods. |
| Pliocene . . . | *Marine* (Mediterranean), *fluviatile* and *lacustrine* (E. Anglia), volcanic eruptions (aquatic and land-plants) | Temperate or sub-tropical, becoming colder towards close. |
| Miocene . . . | *Lacustrine* and *marine* (land and aquatic plants) | Sub-tropical. |
| Oligocene. . . | Chiefly *freshwater* or *estuarine*, but *partly marine*, volcanic activity (land and aquatic plants) | " |
| Eocene . . . | *Marine*, *lacustrine*, *estuarine*, volcanic eruptions (land and aquatic plants) | From temperate to sub-tropical or tropical. |
| Cretaceous . . | Alternations of *marine*, *shallow water*, *marine* with *estuarine* beds, *estuarine* or *fluviatile* (Wealden); volcanic activity (land and aquatic plants) | Tropical in part, and much warmer than at present, especially in Arctic lands. |
| Oolites . . . | *Freshwater* (Purbeck), but *mainly marine*, with *estuarine beds* and coral-reefs (land-plants and aquatic plants) | Sub-tropical. |

GEOLOGICAL CLIMATES (AND RELATION OF LAND TO THE SEA)—*continued.*

| System. | Nature or origin of sediment and flora. | Climate. |
| --- | --- | --- |
| Lias . . . . | *Marine*, with local plant-beds and coral-reefs (land-plants) | Warm, or sub-tropical. |
| Rhaetic . . . | *Marine* (land and aquatic plants) | " " |
| Trias . . . | *Lacustrine* (land plants, aquatic plants), *marine*, *delta formation* (land-plants), glacial conditions, volcanic activity | Warm and dry climate of the Steppes. |
| Permian . . . | *Partly marine*, *partly saline*, *lacustrine*, volcanic activity (land and aquatic plants) | Moist and equable, becoming warmer towards the close. |
| Carboniferous: Upper (A) Lower (B) | (A) *Lagoon type*, *estuarine* and *terrestrial*, with *periodical marine horizons*, formation of coal-seams (land and aquatic plants). (B) *Marine* (volcanic activity towards close) | Moist and equable (perhaps warmer towards close of period). |
| Devonian (A) and Old red sandstone (B) | *Marine* (A) and *lacustrine* (B); volcanic activity (land-plants and aquatic plants) | Probably mild and equable, like south temperate climate. |
| Silurian . . . | *Marine* (deposited in a slowly subsiding area) (? first land-plants) | Probably mild temperate. |
| Ordovician . . | *Marine* (land-area around the N. polar tract) | Probably temperate or sub-tropical. |
| Cambrian . . . | Proximity of land indicated by muddy sediments (evidence of volcanic activity) | Very cold, becoming milder and finally warm, when corals flourished (contemporaneous submarine eruption). |
| Pre-Cambrian . . | In the *upper part marine* (*e.g.* Longmynds) | Climate doubtful. |
| Archæan . . . | Some of the lowest rocks of *volcanic* and *igneous origin* | Evidence of glacial action. |

# Range in Space of Geological Systems.

| Geographical distribution (according to temperature zones). | | | Pre-Cambrian. | Cambrian. | Silurian. | Devonian. | Old red sand-stone. | Carboniferous. | Permian. | Triassic. | Jurassic. | Cretaceous. | Eocene. | Oligocene. | Miocene. | Pliocene. | Pleistocene. | Holocene. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Arctic Belt (down to 60° N.) | 1. | Northern Canada | × | | × | × | | | | | | × | | | × | × | × | |
| | 2. | Greenland | | | | | | | | | × | × | | | × | | | |
| | | Iceland | | | | | | | | | | | | × | | | | |
| | 3. | Northern Europe | × | × | × | × | × | × | × | × | × | × | × | × | | × | × | × |
| | 4. | Bear Is. and Spitzbergen | | | | | × | × | × | × | × | × | | | | | | |
| | 5. | Franz Josef's Land | | | | | | | | | | | | | | | | |
| | 6. | Northern Asia | | × | × | | | | | × | × | | | | | | × | |
| North Temperate Belt (60°–40° N.) | 7. | S. Canada and N. United States | × | × | × | × | × | × | × | × | × | × | × | × | × | | × | |
| | 8. | Central and Southern Europe | × | × | × | × | | × | × | × | × | × | × | × | × | × | × | × |
| | 9. | Central Asia | × | | × | × | | × | × | × | × | | | | | | | |
| North Sub-Tropical Belt (40° to Tropic of Cancer) | 10. | Southern States of North America | | × | | × | | × | × | × | × | × | × | × | × | × | × | |
| | 11. | Northern Africa (part of Arabia and Persia) | × | | | | | × | | × | × | × | | | | × | | |
| | 12. | Thibet and part of China | × | × | × | | | × | | × | × | × | | | | | | |
| | 13. | Japan | × | | | | | | | × | × | × | × | | | | | |
| Tropical Belt (between Tropics of Cancer and Capricorn) | 14. | Central America, N. part of S. America | | | × | | | × | | × | × | × | | | | | | × |
| | 15. | Central Africa and Madagascar | × | | | | | | | | × | | | | | | × | |
| | 16. | India, Malay Archipelago and N. Australia | × | × | × | × | | × | × | × | × | × | | | ? | × | × | |
| Southern Sub-Tropical Belt (T. of Capricorn to 40° S.) | 17. | Central S. America | | × | × | | | | | | | × | | | | | | |
| | 18. | South Africa | × | | | ? | | × | × | × | × | | | | | | | |
| | 19. | Central and Southern Australia | × | × | × | × | | × | × | × | × | × | × | × | × | × | × | × |
| South Temperate Belt | 20. | Extreme S. of America | | | | | | | | | | × | × | | × | | | |
| | 21. | Tasmania | × | × | × | | | × | | | | | × | | | | | |
| | 22. | New Zealand | × | | × | × | | × | | × | × | × | × | × | × | × | × | × |

formation which we are studying, not the species, though each species forms a unit of the whole formation and has to be considered analytically, just as the formation must be studied synthetically also, as a unit on the broader basis, and in its relation to other plant communities.

Plant formations are the largest units the plant ecologist has to deal with. They are determined by the main factors such as soil, water, altitude. Climate in a small degree* influences plant formations, but as a rule plant formations do not extend over wide enough areas for the influence of climate to be reflected in their component elements.

It is the larger zones of vegetation that are especially affected by climate. Humidity,† however, in an insular area, such as the British Isles, does influence the types of plant formation and their distribution.

The British Isles being much more humid along the west coasts than in the Midlands or on the east coasts, are characterised on the west by a greater extent of bog and moorland types of formation which are less dependent on the soil than others, being regulated by the distribution of peat and a heavy rainfall. It is in such western and northern areas that Cotton-grass, Whortleberry, and other types of wet moorland plants are developed. Dry, sandy heaths are conversely more widely distributed over

* So far as the British Isles is concerned. But even here geographical position plays a not unimportant part.

† Regulated by the course of the Gulf-stream, and the distribution of the harder Palæozoic rocks.

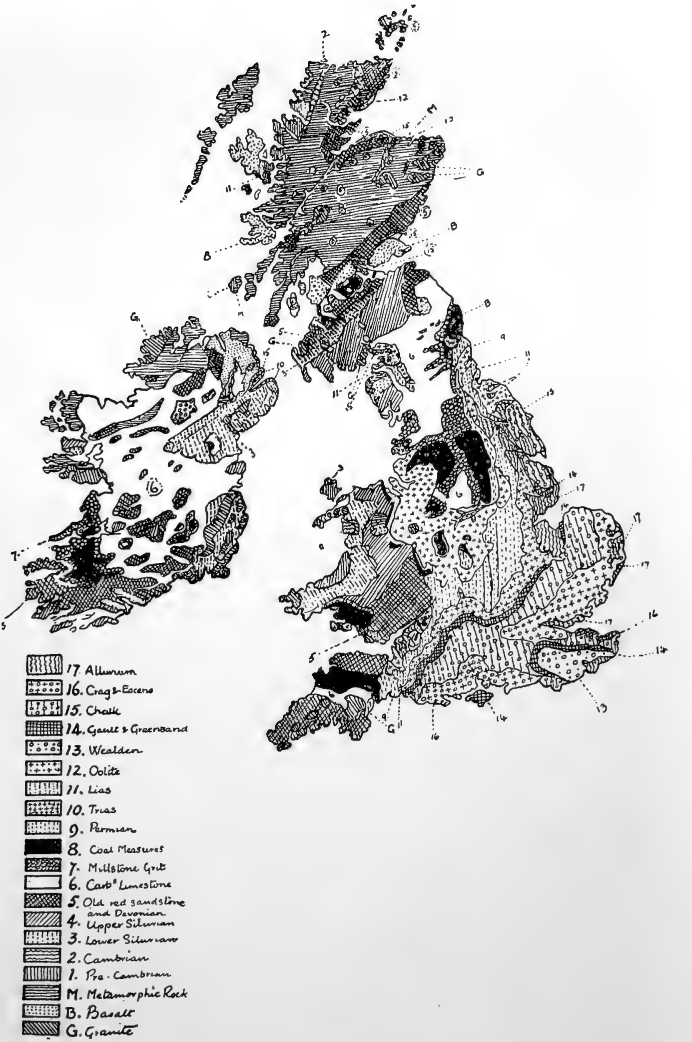



FIG. 11.—MAP OF BRITISH ISLES, SHOWING THE GEOLOGICAL FORMATIONS.

*Emmeline Radford, del.* *See page 71.* *A. Newton, photo.*

the southern, eastern, and to some extent central areas.

Altitude in turn regulates the distribution of aquatic vegetation and fenland, and these are found in the lowland areas in central and eastern England, where, in the last case, the larger rivers have their chief outlets.

Proximity to the sea regulates the distribution ot maritime vegetation, and it is only around the coasts and in inland salt regions such as Cheshire and elsewhere that halophytes or salt-loving plants are to be found.

Primarily the intermediate types of plants that require a moderate degree of moisture are distributed over areas where the soil is not water-logged, or again where the slope or character of the soil, sandy, etc., does not make for dry-soil conditions. The wet clay areas of the Midlands give rise to a moisture-loving type of vegetation. The hilly areas, where the soil is quickly or well drained, or sandy, and where the rainfall is not heavy, are most favourable to the growth of dry-soil types.

The character of the soil determines the nature of the plant formation in the case of land-plants. The chemical and the physical characteristics are both equally important in determining the particular type of vegetation. There are a large number of different geological formations (see Fig. 11) which have broadly western and eastern distribution if we divide the rock formations up into an older series or

the Palæozoic rocks, and a newer series or the Mesozoic, and later Cainozoic rocks, the Jurassic and Tertiary series being confined to the east and south of England, and except in the case of the Oolite and chalk-forming being usually lowland areas.

The Palæozoic rocks lie to the west of England and are found throughout Ireland, covering large parts of Scotland, especially on the west coast. These older rocks coincide more or less with the regions of highest altitude, and to a nearly similar extent those of greatest rainfall. On the contrary the newer formations are dry and lie east of the older rocks, uninfluenced by the effect of the Gulf-stream which is so marked on the west coast, and thus escape those humid conditions to which the older rocks are exposed. The older rocks again are harder, and though subjected to a much longer period of denudation have resisted such forces far better than the newer rocks, which are loose and friable, or being calcareous easily decomposed by the carbonic acid in rain-water (see Fig. 12).

We may split up the various types of geological formations and the different rock-soils they afford into half a dozen types. These are clay and loam, sand, siliceous soils such as those derived from slate, which are close-grained and sticky, etc., limey soil, humus, or peat, saline soil.

Primarily plants may be said to be either fond of a limey soil and calciphile, or not, when they are calcifuge. The same sort of relationship exists

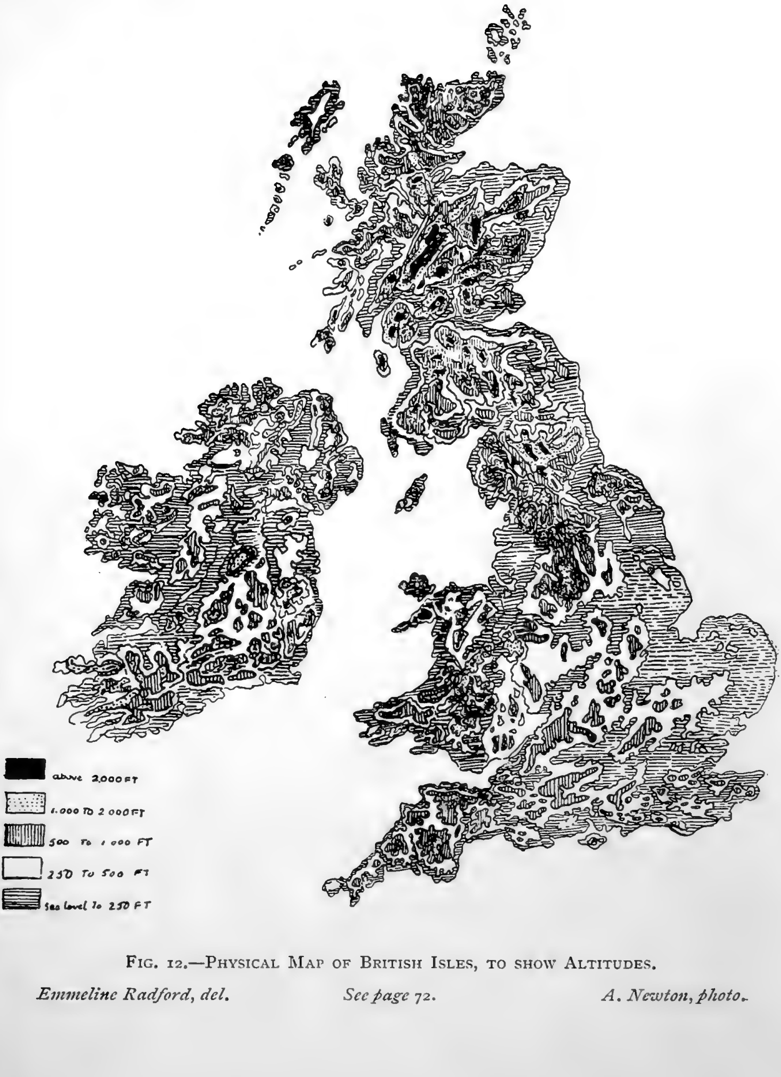



FIG. 12.—PHYSICAL MAP OF BRITISH ISLES, TO SHOW ALTITUDES.

*Emmeline Radford, del.* *See page 72.* *A. Newton, photo.*

between plants and their attitude towards a saline soil. They are either halophile or halofuge, the former constituting a marked type of vegetation termed halophytic.

At one period it may be assumed that this country was more or less entirely covered by virgin forest. There were here and there natural open spaces, due to the character of the soil, *e.g.* as where now it is shallow, or covered by stony *débris*, or where the soil was originally water-logged and covered by thick layers of peat. But even then, as peat deposits show, there were periods when forests covered such sites. And this gives us a clue to the present diversity of plant formations, which would appear to be inexplicable if all the country were originally woodland, unless some general factors made for diversity. For one type of formation arises from another. One may become degenerate and give place to another, as where woodland becomes scrub, or scrub pasture. At the margins of different formations one type may invade another, as where aquatic vegetation or conditions invade meadow land. Thus we get a patchwork arrangement of formations at any one period, and by the law of migration and invasion, during successive periods, variable in length, we may get a succession of plant formations in any one area. Such changes follow well-defined laws, and the transitions from one type to another can be recognised and explained. The variation in water content due to fluctuations in the atmospheric conditions

makes for such changes. Floods, silting up by natural causes, rise or fall in coast level, earthquakes, etc., are amongst the many natural causes.

Man himself, however, in such relatively ancient, civilised, thickly populated countries as the British Isles has brought about the greatest changes.

He has cut down the forests for tillage, fuel, for ship construction, or for dwellings, etc. This has reduced the area of woodland. It has also affected the amount of moisture or rainfall. In place of woods we now have pastures or meadows.

By cultivation he has entirely altered the character of the soil and the nature of the vegetation it supports. This is shown by the great prevalence of ridge and furrow, dating from the Conquest or earlier, when corn was cultivated more extensively than to-day. The disturbance of the soil and the introduction of foreign types owing to cultivation has obviously brought about greater changes in the natural vegetation than can be accounted for readily. But, on the contrary, a good deal of this cultivated land has returned to its former state and may be regarded as purely natural pasture. But the majority of the natural pasture lies either above the zone of cultivation, *i.e.* above altitudes of 1000 ft., or occurs upon such soils as limestone or chalk where the soil is shallow and has not been tilled, or where, as in the last case, there was little original woodland.

A third factor introduced by man is drainage.

This is coincident, as a rule, with the two other factors. It has the effect of entirely altering the water content, and aquatic plants or hygrophiles thus give place to types intermediate between them and terrestrial plants or mesophytes, in their demand for moist conditions. As in the last two cases drainage has mainly disturbed areas that have been most affected. The Fenland is the most extensive area which has been altered by drainage. Tracts originally covered by aquatic or fen formations have become converted into grassland and arable. But by purely natural causes, either in the past or in comparatively recent times, marsh and aquatic vegetation and fenland have been constantly changing places, and this is due largely to natural silting up by the natural formation of shingle beaches on the coast and changes of level.

In other lowland areas aquatic vegetation has become neutral grassland or rush associations, marshes have succeeded aquatic formations, and bog or fen has succeeded marshland, as a greater thickness of peat has accumulated.

Other factors of human origin are the preservation of game and the formation of artificial plantations, especially of conifers, which, except in the case of the Pine,* are not native. A similar artificial effect has been caused by peat-cutting and by furze or heather-burning in upland areas for fuel or for game preservation or allied purposes.

* The Larch found in ancient plant-beds has been re-introduced.

Taking into account all these abnormal causes it is not surprising that a large proportion of plant formations in the British Isles are not natural. Indeed it has been said there is no indigenous woodland. In England the percentage of natural vegetation is not more than 20 per cent. at the most. The aquatic types of vegetation, maritime vegetation, upland moorlands, heaths and Arctic Alpine formations include the bulk of this natural vegetation.

Those formations that have been most largely altered are woodland and the resultant grassland.

Owing to the difference in soil in different parts of the country we have primarily different types of woodland.

The type which is characteristic of *clays* and *loams* is *damp oakwood*, made up of the pedunculate variety of oak. There are in each woodland three main zones or layers of vegetation, the tree zone, the shrub zone, and the ground flora, which may be made up of cryptogams such as mosses, if we take these into account, or of low herbaceous flowering plants, if we exclude the mosses and hepatics, etc.

The woods (see Fig. 13) are of copse type with standards or trees either in *open or close canopy*, and the scrub may be either close or open. The coppice or scrub consists in this case often of Hazel, or of young Oak, Hazel, Birch. Other shrubs are Willow, Cornel, Maple, Hawthorn, various Roses and Brambles.

Such climbing plants as Honeysuckle, Ivy, etc.,

FIG. 13.—A DAMP OAKWOOD, OPEN CANOPY, HAZEL COPPICE, WITH WOOD ANEMONE, ETC.
*G. B. Dixon.* *See page* 76.

FIG. 14.—REMAINS OF THE CALEDONIAN FOREST, OAKS FORMING ORIGINALLY SANDY OAKWOOD, WITH BRACKEN, SHEEP'S SORREL, WOODSAGE, ETC.
*C. R. Mapp.* *See page* 78.

occur with the scrub. In the ground flora are Wood Anemone, Goldielocks, Wood Violet, Wood Stitchwort, Bush Vetch, Avens, Enchanter's Nightshade, Sanicle, Burdock, Primrose, Germander Speedwell, Ground Ivy, Self-heal, Bugle, Twayblade, Woodrush, Tussock Grass, etc.

When a damp oakwood degenerates into *neutral grassland* without a tree or scrub layer, it is characterised by the dominance of particular grass types such as Rye Grass, Crested Dog's Tail, Sweet Vernal Grass, Cock's Foot Grass, etc. The other types include Meadow Crowfoot, Cuckoo Flower, Mouse Ear Chickweed, Red Clover, White Clover, Bird's Foot Trefoil, Yellow Meadow Vetchling, Agrimony, Burnet Saxifrage, Devil's Bit Scabious, Daisy, Common Ragwort, Marsh Thistle, Hawksbeard, Dandelion, Speedwells, Bartsia, Ribwort Plantain, Sorrel, Spotted Orchis, Glaucous Sedge, etc.

When the meadow is lowland, and in proximity to aquatic vegetation, a *rush society* is formed, with Lesser Spearwort, Cuckoo Flower, Marsh Marigold, Ragged Robin, Starwort, Great Bird's Foot Trefoil, Pennywort, Marsh Bedstraw, Water Ragwort, Horsemint, Common Spike Rush, many rushes, sedges, Manna Grass, Rough Meadow Grass, Horsetail, etc.

On *sandy soil* derived from older sands and sandstones the type of woodland is drier, and made up of the *pedunculate oak*, or the *sessile oak*, on shallow soil, or both, with occasional Birch. The scrub consists of Hawthorn, Sloe, Birch, Aspen, Rowan, etc.

The ground flora includes some plants of the damp oakwood (where it is drier), such as Wood Violet, etc., and Beautiful St. John's Wort, Perforate St. John's Wort, Wood Sorrel, Tormentil, Barren Strawberry, Rosebay, Heath Bedstraw, Golden Rod, Hawkweeds, Foxglove, Woodsage, Sheep's Sorrel, Woodrush, Yorkshire Fog, Bent Grass, Bracken, Hard Fern, etc. (see Fig. 14).

The *grass heath* on dry soils is characterised by such plants as Vernal Grass, Wood Violet, Milkwort, *Moenchia*, Sandwort, Pearlwort, Grassy Stitchwort, Purging Flax, Stork's Bill, Gorse, Broom, Lesser Trefoil, Hare's Foot Trefoil, Tormentil, Parsley Piert, Pignut, Milfoil, Mouse Ear Hawkweed, Spear Thistle, Carline Thistle, Harebell, Ling, Heath, Centaury, Dwarf Forget-me-not, Wall Speedwell, Eyebright, Wild Thyme, Knawel, Sheep's Sorrel, Early Sedge, Bent Grasses, Silvery Hairy Grass, Heath Hair Grass, *Sieglingia*, Bracken, etc. (see Fig. 15).

*Heaths* are developed on sandy or gravelly soils, usually dry, with dry peat, or a wetter soil and pure acid humus. Here mosses and lichens often form a thick ground layer. Heaths are interspersed within the dry oakwood, with Bilberry, Heath Hair Grass, and Ling. When more nearly related to the latter the oak-birch heath association forms open areas with oak, birch, and some oakwood ground flora types as Bluebell, Wood Anemone. Amongst the trees are also Beech, Pine, Holly; and the shrubs

include Hawthorn, Gorse, Rowan, Cherry, Crab, Broom, Juniper, Willows, etc.

The ground vegetation includes Ling, Whortleberry, Bell Heather, Bracken, Heath Hair Grass, Woodsage, Tormentil, Cow-wheat, Heath Bedstraw, Common Speedwell, Blue Hair Grass, etc.

On a typical heath on sandy soil, few plants grow below the dominant Ling or Heaths, or Whortleberry, but other characteristic types are found, such as Milkwort, Purging Flax, Gorse, Broom, Heath Hair Grass, Saw Wort, Harebell, Dodder, Red Louse-Wort, Woodsage, Bent Grass, Mat Grass, Purple Moor Grass, Bracken, Hard Fern, etc. On wet heaths, Bog Violet, Sundew, Ling, Cross-leaved Heath, Dwarf Willow, Rushes, Oval Sedge, Purple Moor Grass, Bog Mosses, occur.

In some parts heaths are characterised by *Pine-woods* with Ling, Tormentil, *Trientalis*, Whortleberry, Bearberry, Cowberry, Heath Hair Grass, Juniper. Lichens occur on black peat.

On *siliceous soils* the chief tree is the *sessile oak*, with *birch* at higher altitudes, above 1000 ft., up to which (or about 800 ft.) the former grows. With these grow Wych Elm, Rowan, Holly, Ash, Aspen, Lime, Cherry. There is a shrub layer of many species of brambles, and roses, with Sloe, Hawthorn, Broom, Gorse. According as the soil is damp or dry, the ground flora varies somewhat. In the former the characteristic plants are the Wood Anemone, Bitter Cress, Red Campion, Wood Stitchwort, Water

Avens, Golden Saxifrage, Sanicle, Valerian, Butterbur, Wood Loosestrife, Marsh Forget-me-not, Knotted Figwort, Archangel, Dog's Mercury, Bluebell, Woodrush, Millet Grass, etc. The drier woods are characterised by Wood Violet, Milkwort, Three-nerved Sandwort, Heath Bedstraw, Woodsage. In more open places grow Dwarf Furze, Heath Bedstraw, Ling, Cow-wheat, Woodsage, Woodrush, Hard Fern, etc.

*Siliceous grassland* is characterised by the predominance of Mat Grass, with Silvery Hair Grass, or Purple Moor Grass, each forming a distinct type of pasture.

In the former other common plants are bracken, Bent Grass, Sheep's Fescue, Common Rush, etc., with Ling, Heaths, Cowberry. In the latter Lesser Spearwort, Cross-leaved Heath, Cowberry, Rushes, Cotton Grass, Purple Moor Grass, and Mat Grass occur with others (see Fig. 16).

The *older limestone* woods are characterised by the Ash, with Wych Elm, Hawthorn, Juniper, Yew, Willows, Aspen, Beech, Hazel, Alder, Birch, and in the scrub Limes, Spindle Wood, Blackthorn, Cornel, Wayfaring Tree, Privet, and Spurge Laurel.

In the ground flora in *marshy places* are included Meadow Sweet, Hairy Willow Herb, Valerian, Butterbur, Mints, Marsh Forget-me-not; on *wet soils* Wood Anemone, Pilewort, Red Campion, Wild Strawberry, Woodruff, Marsh Thistle, Archangel,

FIG. 15.—HEATH-LAND ON SANDY SOIL, WITH BRACKEN, GORSE, ETC.
*G. B. Dixon.* *See page* 78.

FIG. 16.—SILICEOUS GRASSLAND (WET TYPE), WITH WHORTLEBERRY (AND *Erica cinerea, Calluna vulgaris, Molinia cærulea*).
*Messrs. Flatters and Garnett* (Copyright). *See page* 80.

Ramsoms, Lords-and-Ladies, Wood Sedge, Rough Brome Grass.

On dry soils Dog's Mercury, Moschatel, are typical, and amongst others the following also grow on such soils, Ground Ivy, Hairy St. John's Wort, Nettle, Wood-sage, Lily-of-the-Valley, Melic Grass, Three-nerved Sandwort, Whitlow Grass, Rue-leaved Saxifrage, Biting Stone Crop, Wild Thyme.

On *limestone scrub* Roses, Hawthorn, Ivy, Hazel are common, with Rockrose, Salad Burnet, Hairy St. John's Wort, Oxeye Daisy, Woolly-headed Thistle, Primrose, Ground Ivy, Marjoram, Kœleria, *Brachypodium gracile*, etc.

*Limestone grassland* is characterised by such plants as Hairy Violet, Ladies' Fingers, Horseshoe Vetch, Rockrose, Squinancy Wort, *Scabiosa Columbaria*, Clustered Bellflower, Marjoram, Bee Orchis, Fly Orchis, Shining Oat Grass, Kœleria, *Bromus erectus*, *Brachypodium pinnatum*.

*Limestone swamps and heaths* are also found to be characterised by a number of plants, such as, in the first case, Globe Flower, Meadow Sweet, Water Avens, Grass of Parnassus, Hemp Agrimony, Melancholy Thistle, *Primula farinosa*, Jacob's Ladder, etc., and in the latter by Shining Cranesbill, *Viola lutea*, Rue-leaved Saxifrage, Rockrose, Squinancy Wort, *Antennaria dioica*, Knapweed, Greater Knapweed, Felwort, Marjoram, Scented Ribgrass, Frog Orchid, Early Sedge, Barren Oat Grass, etc.

The plant associations of the *chalk* are charac-

terised by the predominance of the *beech*, with White Beam, Ash, Bird Cherry, Yew, Dog's Mercury, Sanicle, Wood Violet, Wild Strawberry, Enchanter's Nightshade, Hairy Violet, Orchids such as the Helleborines, and Bird's Nest Orchid, Bird's Nest, Bearsfoot, Deadly Nightshade, Spurge Laurel, Butcher's Broom. Sometimes the Ash is dominant. In other cases woods are formed by the Yew or the Box.

A *scrub association* is formed with Hawthorn and Sloe, and Clematis, Holly, Spindle Wood, Buckthorn, Field Maple, Sloe, Dewberry, Sweetbriar, Roses, Cornel, Elder, Guelder Rose, White Bryony, Privet, Spurge Laurel, Hazel, Juniper, Butcher's Broom, Dog's Mercury, and many Orchids.

The *chalk grassland* is characterised by the abundance of Sheep's Fescue, with Erect Brome Grass, Yellow Oat Grass, Sylvan Brome Grass, Rockrose, Salad Burnet, Squinancy Wort, and where the soil is sandy Ling and Tormentil occur.

On *chalk pasture* Dyer's Weed, Base Rocket, Hairy Violet, Milkwort, Bladder Campion, Purging Flax, Sainfoin, Salad Burnet, Dropwort, Squinancy Wort, *Scabiosa Columbaria*, Cudweed, Carline Thistle, Musk Thistle, Greater Knapweed, Bristly Ox-tongue, Spiked Rampion, Yellow Wort, Toadflax, Mullein, Basil Thyme, Wood Basil, Calamint, Ladies' Tresses, Pyramidal Orchis, Man Orchis, Musk Orchis, Bee Orchis, Fragrant Orchis, Glaucous Sedge, Timothy Grass are common.

On *marls and calcareous sandstones* the woodland is

FIG. 17.—AQUATIC VEGETATION, NEARLY STAGNANT WATERS, FLOATING-LEAF ASSOCIATION WITH *Potamogeton natans*.

*Messrs. Flatters and Garnett* (Copyright). *See page* 83.

FIG. 18.—AQUATIC VEGETATION, SLOWLY-FLOWING WATERS, REED-SWAMP ASSOCIATION WITH *Phragmites communis*.

*C. R. Mapp.* *See page* 83.

*ash oakwood* with Hazel, Wayfaring Tree, Spindle Wood, Clematis, Cornel, Privet, Field Maple. The ground flora includes Wood Violet, Oxlip, Hairy St. John's Wort, Gromwell, Nettle-leaved Bellflower, Herb Paris, Meadow Saffron, Helleborines, Stinking Iris or Gladdon, Dog's Mercury, Finger Sedge, etc.

*Aquatic vegetation* consists of fresh-water aquatic formations with an association of plants that grow in foul water, with plankton, and submerged-leaf, floating-leaf, and reed swamp associations.

Where the water is relatively rich in mineral salts in almost stagnant water the submerged plants include Mare's tail, Water Milfoil, Water Violet, Canadian Waterweed, etc., and those with floating leaves include Water Buttercups, Yellow Water Lily, Amphibious Knotgrass, Arrowhead, Ivy-leaved Duckweed, Least Duckweed, Pondweed (see Fig. 17), Manna Grass.

In the *reed swamp* grow Purple Loosestrife, Hairy Willow Herb, Water Dropwort, Yellow Loosestrife, Great Water Dock, Rushes, Pond Sedge, etc. (see Fig. 18).

In *slowly flowing waters* there are different types of Water Buttercup, Water Dropwort, Bur Reed, Pondweed, Bulrush, and at the margin Brookweed, Marsh Forget-me-not, Marshwort, Great Hairy Willow Herb, etc., with floating-leaf types as Yellow Water Lily (see Fig. 19), Duckweed, and in the reed swamp Meadow Rue, Yellow Rocket, Meadow Sweet, Reedmace, Yellow Flag, Water Plantain, Sedges, Sweet Reed Grass.

In waters poor in mineral salts, as in lowland and highland lakes, etc., are found Quillwort, Water Lobelia, Awlwort, Pillwort, Shoreweed, Floating Bur Reed.

The submerged species of the highland loch vegetation include Bladderwort, many Pondweeds, *Juncus bulbosus, Eleocharis acicularis, Scirpus fluitans*, etc.

Amongst those plants with floating leaves are included White Water Lily, Yellow Water Lily, *Apium inundatum*, Amphibious Knotgrass, and in the reed swamp grow Bogbean, Common Spike Rush, Bulrush, Prickly Twig Rush, Sedges, Reed, etc.

In quickly flowing streams the water may be non-calcareous and such associations include Lenormand's Water Buttercup, Ivy-leaved Water Crowfoot, *Glyceria fluitans*, Starwort, Water Blinks, Bog Stitchwort, etc. Where the water is calcareous other types are found (see Fig. 20).

The *marsh formation* is characterised by an association of Alders and Willow with also Elm, Ash, Oak, Guelder Rose, Birch, Field Maple, and Creeping Buttercup, Pilewort, Marsh Marigold, Water Cress, Cuckoo Flower, Ragged Robin, Square-stalked St. John's Wort, Golden Saxifrage, Great Hairy Willow Herb, Small-flowered Willow Herb, Marsh Bedstraw, Cleavers, Valerian, Marsh Thistle, Creeping Jenny, Comfrey, Tufted Scorpion Grass, Marsh Forget-me-not, Figwort, Brookweed, Skullcap, Great Water Dock, Marsh Helleborine, Spotted Orchis, Yellow Flag, Wood Club Rush, Panicled Sedge, Pendulous

FIG. 19.—AQUATIC VEGETATION, REED-SWAMP ASSOCIATION, AND FLOATING-LEAF ASSOCIATION WITH YELLOW FLAG, BULRUSH, YELLOW WATER-LILY.

*C. R. Mapp.* *See page* 83.

FIG. 20.—AQUATIC VEGETATION, SLOW-FLOWING STREAM, POOR IN MINERAL SALTS WITH *Ranunculus penicillatus*.

*G. B. Dixon.* *See page* 84.

Sedge, Bottle Sedge, Sweet Reed Grass, Tussock Grass, Water Grass, Rough Meadow Grass, Manna Grass, etc.

In the Broads there is a *fen association* with a flora which grows on peat soil, and, where there is alkaline ground water, akin to the marsh formation.

The dominant plants are Reed, Prickly Twig Rush, *Juncus obtusiflorus*, Purple Moor Grass, Sedges, Cotton-grass, Berry-bearing Alder, Sweet Gale, Privet, Bog Orchis, Sundew, Winter Green, or Manna Grass, Sweet Reed Grass, Rough Meadow Grass, with Ragged Robin, Meadow Sweet, Marsh Bedstraw, Valerian, Scorpion Grass, Privet, Meadow Rue, etc. With these generally occur such plants as Marsh Marigold, Ragged Robin, Meadow Sweet, Angelica, Water Dropwort, Marsh Cinquefoil, Purple Loosestrife, Marsh Bedstraw, Bog Bedstraw, Valerian, Yellow Loosestrife, Scorpion Grass, Marsh Helleborine, *Orchis incarnata*, Prickly Twig Rush, Purple Moor Grass, Reed, Wood Reed Grass, various Sedges, etc.

Bog Mosses occur and contribute to form peat. Moors tend to form in such cases. A carr occurs where trees occupy the fens. Fen carr is characterised by trees growing in the fen, and the trees are of later origin. Swamp carr occurs where the trees are marginal. Carr ultimately developed from both is called Ultimate carr.

In some cases grass fen is formed with pastures either made up of Rough Meadow Grass, or of reeds,

or of various grasses, such as Bent Grass, Vernal Grass, Yorkshire Fog, *Sieglingia*, Quaking Grass, etc.

Where the fens adjoin the coast a sub-maritime fen pasture association is formed.

*Moorlands* are lowland or upland. The *lowland moors* are found in the vicinity of estuarine and lacustrine deposits where aquatic vegetation has formerly flourished.

There are associations of Cottongrass, with *Scirpus cæspitosus*, Ling, Cross-leaved Heath, Wild Rosemary, with *Sphagnum* in pools, Beak Sedge, Cranberry, Bog Asphodel, Sundews.

The succession is *Sphagnum* moor, Cottongrass moor, Cottongrass-Heather moor, Heather moor, Birch scrub, Birch thicket, Birch wood. With these are marginal associations with Alder, Willow, and other tree types, Bogbean, Marsh Cinquefoil, Panicled Sedge, Reed, Water Violet, etc., Purple Moor Grass, Ling, *Sphagnum*, etc., Cottongrass, Sweet Gale. Peat, with fen peat below and moor peat above, is formed to a depth of 12—15 ft.

In the lacustrine moors the peat consists of lake mud, shell marl, amorphous peat, *Hypnum* peat, reed and sedge peat, wood peat, *Sphagnum* and *Eriophorum* peat.

The valley moors of the New Forest exhibit the following succession: Alder thicket, Marsh formation, Reed-swamp association, Purple Moor Grass association, Bog moss or moor formation.

The *upland moors* consist of associations on thicker

peat up to 30 ft., usually at higher elevations. They include the following associations: *Bog moss association, Cottongrass association,* with a peat bed of four layers. A third association is formed by *Scirpus cæspitosus,* with Ling, Cottongrass, Sundew, Cowberry, etc. (see Fig. 21).

The *Bilberry moor* association is dominated by Whortleberry, and is rather variable in the component species, due to the type of habitat. The *Heather moor* association is characterised by Ling, on dry peat with remains of Birch. The following are typical plants: Dwarf Furze, Heath Bedstraw, Bell Heather, *Juncus squarrosus,* Bent Grass, Bracken; and here and there the Whortleberry becomes abundant. Rush societies and others formed in damp hollows are also found in the same habitats.

On boulder clays a *grass moor* occurs between the *Scirpus cæspitosus* association and siliceous grassland. Grasses, rushes, sedges, are characteristic. Purple Moor Grass and Mat Grass are abundant. Distinct associations are formed by each with characteristic species.

Above 2000 ft. there is *arctic-alpine vegetation,** which is found in Scotland, as on Ben Lawers, and on the higher hills and mountains of England and Wales. Several zones are recognised, such as the zone of cultivation and pasture, the latter above the former as a rule and less altered. Above these comes a

* This has been studied especially by Mr. W. G. Smith.

zone of moorland associations and a heather whortleberry association. Above the grass moor comes the true arctic-alpine association made up of the arctic-alpine grassland formation with an abundance of *Alchemilla alpina*, with Highland species, as in the grassland, and sub-alpine species, with several dominant grasses, and others locally abundant.

The upper arctic-alpine formations consist of two formations, that of mountain-top detritus, and the arctic-alpine chomophyte vegetation, of crevices and clefts. Here grow cushion plants, mat plants, rosette plants, as *Silene*, *Saxifraga*, *Sedum*. Of the chomophyte vegetation there are several types, such as open communities on exposed rock-faces, associations of sheltered ledges, of shade chomophytes, and of hydrophilous chomophytes, the latter consisting of moss communities and sedge communities.

The vegetation of the sea coast* consists of the *salt-marsh formation*, which includes a Glasswort association and a Cordgrass association, a general salt-marsh association, a Sea Manna Grass association, a Sea rush association (see Fig. 22).

There are also associations of spray-washed cliffs and rocks, and brackish-water associations.

The *sand dune formation* includes an association of strand plants, a Sea Couch Grass association, a Marram Grass association, fixed dune associations, and dune marsh associations.

* As to the maritime formations consult the works of Prof. F. W. Oliver.

FIG. 21.—UPLAND MOOR, *Sphagnum*-MOSS ASSOCIATION, WITH SWEET GALE, COTTON-GRASS, ETC.

*Messrs. Flatters and Garnett* (Copyright). *See page* 87.

FIG. 22.—NORFOLK SALT-MARSH FORMATION, AND SHINGLE BEACH COMMUNITY IN BACKGROUND, WITH SEA ASTER, SEA BLITE, SAMPHIRE, ETC., IN FORMER, YELLOW HORNED POPPY, SEA CAMPION, SEA PURSLANE, IN THE LATTER.

*The Author.* *See page* 88.

*Shingle beach communities* occur along the coast, as at Blakeney, Chesil Beach, etc.

## 20. The Origin of Plants and the British Flora.

If we go back to the time when the very earliest traces of plant life that have been discovered grew on the earth, we are forced to admit that our evidence is at present very incomplete. In Pre-Cambrian beds only graphitic material supplies any data as to what the most primitive plants were like. Even here, we are at a dead loss as to their nature, for the graphite which it is suggested may originally have been formed from plants is a structureless form of carbon.

Still later the earliest plants are very imperfect. But some have been referred to Algæ or Seaweeds. And it seems probable that life, plant as well as animal, began in the sea, for the earliest deposits containing fossils are of marine origin, and there was certainly no true terrestrial flora till much later. Doubtless the present day fresh-water Green Algæ are derived from some of the marine Algæ, which flourished at the dawn of plant-life on this globe.

From these Green Algæ other types of plants originated, and gradually the direct line of evolution of the higher plants became established. But as to how and when we are as yet practically in the dark. In the Devonian rocks of America, in particular, higher types are ushered in, such as Horsetail-like types,

Club Moss types, Fern types, and some of the still higher Gymnospermous extinct plants, Cordaitales, and some Pteridosperms, and Sphenophylls, all the three last being extinct types.

To seek for the origin of these types is at present impossible. In the Cambrian and Silurian rocks only anomalous types, possibly Algæ or possibly Lycopod types, occur. But the evidence favours the view that the Devonian types were derived from some earlier types whose remains have not been preserved. They are less specialised, or more primitive than the later Carboniferous types of the same groups.

In the Coal-measures the flora is far more luxuriant and rich in species than the Devonian. Moreover, a new type or habit is introduced in the plants with seed-like fructifications, or the Pteridosperms, and Lycopods with the same characteristics. Special adaptations to the humid conditions were introduced in the secondary wood of the arborescent types of Horsetails and Club Mosses. The Cycad-like character of some of the so-called ferns, and some other plants also introduces us to a higher type. Coniferous types occur at the close of this period, and in the Permian in which the flora is more or less the same. The Ginkgo-like type is foreshadowed in part in the Cordaitales which also combine coniferous characters. We thus have in the Coal-measures the synthetic types from which in later epochs, Cycads, Conifers, and Ginkgo have been evolved. Moreover, the seed habit is also in the Coal-measures developed as the

beginning of a line of ancestors leading on to the Angiosperms, a still higher group.

The Mesozoic rocks bring us indeed to a period when Gymnosperms were in the making, and attained a high state of development. The Palæozoic was the age of the most primitive plants, and at its close of the Vascular Cryptogams, especially characteristic of the Devonian, Carboniferous and Permian. At the close of this period, a southern continent was in existence, Gondwanaland with a flora like the two last, but differing in character in the Northern Hemisphere from the Southern type, characterised by Glossopteris.

In the British Isles we have no Muschelkalk, but abroad in this formation, and in the latter Trias (Bunter, Keuper and Rhætic) there was a development of Cycad-like plants. The Horsetail types and their allies were more closely related to the present-day forms. Lycopods were not abundant. The flora was more xerophytic than in the later part of the Palæozoic era. Conifers were more abundant. In the Rhætic beds there are also new types of ferns which connect this period with the succeeding Lias, as do the Araucaria-like Conifers. The Lias itself is remarkable for the development of the latter, and the Cycad-like types, some of which recall the later *Bennettites*.

It is in the Jurassic that we meet with an abundance of Cycads, and Ginkgo, an extraordinary type represented to-day by the Maiden-hair Tree of Japan,

first appears. In this period also some forms occur which may be related to another Gymnospermic type, *Gnetum*. There are as yet no traces of the higher Angiospermous types, at least definitely allied to them, though in some of the later Jurassic beds, plants referred to Monocotyledons appear. But these, like the earliest plant types, are anomalous and of uncertain affinity. The greatest interest, however, centres around the Cycadaceous *Bennettites*, which appears to be the ancestor* of our modern Angiosperms, and in its turn it would seem to be in a direct line with the earlier Pteridosperms or fern-like plants with seeds, or seed-like structures. The embryo was dicotylar. The flower was bisexual or hermaphrodite. The female portion was central and the male sporophylls were marginal. It is suggested that *Magnolia* may be connected with the type of earliest Angiosperms to which the Jurassic *Bennettites* gave rise. This modern type is a member of the Ranales and many of them are monocotylous, and the problem of the origin of Monocotyledons and Dicotyledons seems to be related to this problem.

But it is in the early Cretaceous that we find that both Monocotyledons and Dicotyledons suddenly make their appearance, so that the connecting link must have been some synthetic type (*cf.* the Coal-measure flora) which gave rise to both.

The Tertiary epoch is essentially the era of Angiosperms. The climate was tropical and Palms and

* Or directly connected with it by some other Pro-Angiosperm.

Laurels, etc., grew in this country where we have to-day a temperate flora.

The origin of the British flora is as difficult to solve as that of the origin of Angiosperms. The change of climate after the Eocene brings us to Pliocene times when it was much colder, and in the pre-Glacial flora we have many plants that are living to-day along with some southern types such as the Water Chestnut of the Mediterranean, which are no longer found here.

With the Glacial epoch arctic conditions were introduced. There had been anterior to this in the arctic regions a flora of a tropical character in Greenland and elsewhere, and this flora was swept away before Pliocene times. But it may have spread to Europe from America, where in Cretaceous times a rich Angiospermic flora flourished, to be followed by a later, equally rich Tertiary flora *viâ* the northern regions if we cannot postulate then a land bridge or "Atlantis" between Europe and America.

When, at any rate, colder conditions prevailed, Pliocene, and later Pleistocene modern types were evolved in America and in Europe.* In this area the southern plants which spread from the Mediterranean area northwards were driven southwards by the Ice Age, whilst northern arctic plants came south with arctic animals such as the Mammoth and the Reindeer. During this Glacial period there were milder Interglacial periods. Some of the plants of

* We know less generally of the floras of the Southern Hemisphere than of the Northern.

the pre-Glacial period are found in the plant-beds of these milder intervals.

Some northern plants occur in early Glacial periods such as the Arctic Willow and Dwarf Birch. Except the Birch and Alder there were no forest trees apparently. In the Interglacial beds the plants are mainly those living to-day with some southern types such as *Acer monspessulanum, Naias graminea, N. minor.*

The northern types are absent. In late Glacial times there were numerous arctic types including the Arctic Willow.

On the return of milder conditions these last northern types were driven to the summits of lofty hills in this country, where they are represented to-day by the Arctic Alpine flora of Saxifrages, etc.

The southern types were now able, on retreat of the ice, to take possession of these islands again. Previous to the Ice Age the country was united to the continent, but after an elevation it became disconnected, and after the cold conditions were succeeded by milder, introduction from elsewhere would appear to have taken place, as Mr. Clement Reid considers, rather by accidental means—wind, the agency of birds, currents, etc.—than by migration. And the existence to-day in Cornwall and Ireland of a southern or Lusitanian flora is to be attributed rather to such agencies than to a possible former land connection between Spain and Portugal and France with the British Isles, and the persistence of these temperate

types during the Glacial period in their present areas. The land-connection being pre-Glacial, the last condition is an inevitable conclusion or corollary of the first. The same applies to the argument as to the occurrence of American plants in Ireland if the existence of a former land-bridge (which in Tertiary times no doubt did exist) is employed to explain their present occurrence in this area, following their survival of the Glacial epoch if indeed they are so ancient.

Both these explanations (*i. e.* land-bridge theories) are interesting, but there is hardly as yet sufficient evidence to prove them. The balance appears to be in favour of accidental means analogous to the present colonisation, by such accidental means or by, for instance, the various agencies of dispersal of plants upon volcanic islands or areas where vegetation has been destroyed by eruptions.

# CHAPTER I

## GAMOPETALÆ

*(Continued; see Vol. II, p. 337).*

### 47. The Ash Group (Summary).

*(Introductory Volume, p. 155.)*

IN the British Isles we have but two members of the Order Oleaceæ, the Ash, and the Privet. The former is described in the Introductory Volume, p. 156.

Nearly four hundred species of this order are known, belonging to over twenty genera. They are found in the tropical and warm temperate zones, but are more confined to the northern regions, and are characteristic of the East Indies.

The Oleaceæ include trees and shrubs and tall climbing plants. Two divisions have been made—Oleoideæ, in which the seeds are pendulous and the fruit is not constricted, with four or two corolla-lobes, including *Fraxinus, Forsythia, Syringa, Phillyrea, Olea, Ligustrum*; and Jasminoideæ, in which the seeds are erect, the fruit vertically constricted, and with five or more corolla-lobes, which overlap,

and are obliquely twisted in bud, including *Jasminum*. In *Fraxinus* the leaves are compound, pinnate, and the fruit is dry, oblong, linear; in *Ligustrum* the plants are shrubs, with simple leaves, and the fruit is a berry.

In the Order generally the branches are opposite. The leaves are simple or compound, pinnate, and, though generally opposite, are sometimes alternate, and often entire. There are no stipules.

The inflorescence is either a terminal raceme or a cyme, frequently with bracteoles. The flowers are regular, hermaphrodite, or occasionally unisexual, the plant being, in the case of the Ash, polygamous or diœcious. The flowers are white or green, and the parts are 2—6 in number. The flower may be polypetalous or apetalous. The calyx is regular, inferior, four-lobed, or without any lobes, valvate in bud. The corolla is hypogynous, regular, four-lobed, or wanting, deciduous, or there may be four free petals. The parts are valvate in bud. The two stamens are epipetalous or hypogynous, usually transverse, and alternate with the carpels. There is no disc. The ovary is two-celled, each chamber containing one or two seeds. The stigma is two-lobed. The style is simple, or absent. The fruit is a berry, drupe, or capsule, or a schizocarp, with 1—4 seeds.

The flowers are wind-pollinated in the Ash, and the fruit in this is also wind-dispersed. In *Ligustrum* the berry is dispersed by birds.

The Ash is a useful timber tree. Privet and many of the other types cited are ornamental shrubs.

### PRIVET (*Ligustrum vulgare*).

Universally distributed, the Privet is one of our most generally planted shrubs. Few thickets or plantations are without a fair-sized patch of Privet, which serves as a good covert for game.

In the British Isles the Privet is generally distributed in England as well as in Scotland, and it occurs in Ireland; but is not considered to be native anywhere but in the south, and in England it is held to be native only in those areas where a chalk soil occurs, or upon cliffs by the sea.

The habitat is woods and thickets. Privet is found in damp oakwoods on clays and loams, in ashwoods on limestone, in the scrub association on chalk soils, on marls and calcareous sandstones in ash oakwoods, and in fen associations, and in the ultimate carr developed from swamp or fen carr.

Privet is a shrub with the usual shrub habit. It is almost an evergreen. The plant is without hairs. The branches are long and slender, with smooth bark. The leaves are entire, on short stalks, oblong to lance-shaped, acute.

The flowers are in terminal cymes forming a thyrsus, short and compact, the flowers white, small, densely arranged. The calyx is four-cleft, tubular, with small teeth, and it falls. The corolla is funnel-shaped, the limb spreading, with four lobes,

*The Author.* Fig. 23.—Privet (*Ligustrum vulgare*). *See page* 98.

*W. E. Mayes.* Fig. 24.—Greater Periwinkle (*Vinca major*). *See page* 101.

valvate in bud. There are two, rarely three, stamens, which are included. The berry is round or ovoid, purplish-black, rarely yellow. The endosperm is hard.

The Privet reaches a height of eight or ten feet, and flowers in June and July, being a perennial shrub.

Honey is secreted at the base of the tube, and is concealed. The tube is only 3 mm. long, and accessible to short-lipped insects. The anthers and stigma ripen together. The anthers open wide. They are sometimes distant, and then an insect may touch them with one side of its head, the stigma with the other side. But in other cases they are close and arch over the stigma. In spite of the sweet scent and honey, the flowers are visited more frequently by nocturnal Lepidoptera than by diurnal insects. Other visitors are bees, flies, and beetles.

As the berry is fleshy it is dispersed by the agency of birds.

The following names are cited for Privet: Brivet, Pivert, Prie, Prim, Primrose, Primwort, Print, Privet, Privy, Privy Saugh, Skedge or Skedgwith, Skerrish.

The berries yield a rose or green dye, and an oil, which has been used in Germany for culinary purposes. The green dye has been used for woollen cloth.

LIGUSTRUM VULGARE.—*In the illustration* (*Fig.* 23) *are shown the entire, lance-shaped, shortly-stalked leaves, and the round, shining berries, which are close and numerous.*

### 48. The Periwinkle Group.

In the Order Apocynaceæ only two species are included which are found in the British Isles, the Greater and the Lesser Periwinkle.

About one thousand species of Apocynaceæ which are included in one hundred and thirty odd genera are known. They are chiefly tropical, but a few are found in the temperate zone. The members of this order differ from the Gentian group in the fact that the ovary is completely divided into two cells or two carpels which are distinct, and the stigma is entire. The affinities of the Order are with the Asclepiadeæ (where, however, anthers and stigma are united) and Rubiaceæ.

Most of the plants are trees or shrubs, but a few are herbaceous, and most are twining plants and climbers, rarely erect. They contain a milky juice. Some of the tropical plants are true lianes. The leaves are simple, opposite, rarely in whorls, entire, sometimes evergreen as in *Vinca*. There are no stipules, or when present they are exceedingly rudimentary, and are interpetiolar and small.

The inflorescence is a panicle at first, the later branches cymose. The flowers are regular, sometimes solitary, and possess both bracts and bracteoles. The flowers are hermaphrodite. The parts of the flower are in fours or fives. The calyx is gamosepalous, with five sepals, the lobe deep, quincuncial, and the odd sepal is posterior. The calyx is inferior. The corolla

is gamopetalous, with five lobes, hypogynous, funnel-shaped or salver-shaped, regular, deciduous, and valvate or twisted in bud. The throat is naked or there may be scales, hairy within. There are five stamens, which are epipetalous, on the throat or tube of the corolla, and alternate with the petals. The filaments are very short and included. The anthers are free, attached by the base or united at the base and adhere to the stigma. The pollen is large and granular. The anther-cells may be filled with pollen to the base, or empty below and prolonged into rigid spines. There is usually a disc which is annular. The pistil is syncarpous, and consists of two carpels which are superior, free or united below. The style is short, dilated. The ovules are numerous and pendulous. The fruit consists of a berry or drupe or two many-seeded follicles. The seeds are flattened, often winged, or provided with a crown of hairs and then dispersed by the wind.

The anthers and stigma ripen together. The seeds are dispersed by the wind, being blown out of the follicles.

Some members of this group are poisonous as the Oleander. One, the Cow Tree, yields a milky juice.

### GREATER PERIWINKLE (*Vinca major*).

This lovely wild flower is a familiar feature in old-fashioned gardens, where it is often grown in shady spots on banks and rockeries. From such spots it is frequently found to spread to more natural habitats.

In the British Isles the plant is not native, but naturalised. It occurs in the south of England and also the north, and in Ireland. It is everywhere naturalised.

The habitat is woods, copses, plantations, shady banks, hedges, and elsewhere. Sometimes it may be found at a distance from habitations, but usually it grows near dwellings at the base of walls, on banks, etc.

The Greater Periwinkle has a creeping or nearly erect habit. The rootstock is long and creeping with trailing barren shoots and erect flowering stems, which root at the extremity and are simple. The leaves are broadly ovate, and evergreen, shining, heart-shaped below, fringed with small hairs at the border, thus distinguishing it from the Lesser Periwinkle.

The flowers, borne on erect flower stems, are blue or purple, large, the mouth angular, the corolla salver-shaped. The broad tube is narrow at the mouth, closed with hairs. The flowering stems lengthen after flowering. The lobes of the calyx are fringed with hairs, and are as long as the corolla-lobes. The ultimate flower-stalks are shorter than the leaves. The anthers are curved. The plant rarely sets seed. The fruit is a follicle.

The plant is prostrate and spreads to a distance of three to six feet. The flowers are in bloom from April till June, and the plant is a herbaceous perennial.

The flowers secrete honey in two yellow nectaries at the base of the ovary, which is concealed. The

tube is long, 15–16 mm. in length, and only insects with a proboscis of 11 mm. can reach the honey. The honey is protected from rain and creeping insects by the hairs at the narrowed mouth of the tube. The bent stamens are situated on the corolla half-way up the tube, and the hairy anthers bend over the stigma. The conical stigma is dilated above, forming a flat plate with sticky margins, and is hairy above and between this border. On this central portion the anthers shed pollen, but it does not reach the plate below. Insects, however, inserting their proboscis between the style and anthers detach the pollen-masses in withdrawing, and bear pollen away to a fresh flower. The chief visitors are bees.

The seeds, when produced, are blown by the wind out of the follicle, which opens above.

The greater Periwinkle is also called Band-plant, Blue-bell, Blue Buttons, Cockle, Cut-finger, Dicky-Dilver, Periwinkle, Pervenke.

VINCA MAJOR.—*In Fig. 24 are shown the creeping, trailing stem, with opposite, stalked leaves, ovate and heart-shaped below. The flowers on erect stalks have an angular mouth.*

## 49. THE GENTIAN GROUP (SUMMARY).

*(Introductory Volume, p. 164.)*

Of the Order Gentianaceæ there are about seven hundred and fifty species, which are included in sixty-four genera. The group includes plants of very different growth-habit, and characteristic of diverse

types of habitat. They are found in all parts of the world, chiefly in the temperate regions, often at high altitudes, some being arctic alpine. A few, as some of the Centauries, are halophytes. The Bogbean is a marsh plant. The Gentians are moorland or heath plants. *Gentiana prostrata* grows at 6000–9000 ft. in Europe, in the Rocky Mountains at 16,000 ft., whilst at the Behring Straits, it is found at or near sea level. The colours of the flowers of species found in Europe are blue, whilst in S. America and New Zealand the flowers are red. Only a few are yellow, *e.g. Chlora*, or white (*e.g.* Bogbean).

A few of these plants are shrubby, but most of them are perennial, herbaceous types, with rhizomes. Some of the Gentians are annual. The leaves are usually entire, opposite, without stipules. In the Bogbean they are trifoliate. Rarely the leaves are in whorls. In *Limnanthemum* the leaves are floating and alternate.

The inflorescence is cymose, terminal or panicled, dichotomous. There is only one flower in each fork. The flowers are regular, solitary, with the parts in fours or fives. They possess bracts and bracteoles, or not. The calyx is gamosepalous, inferior, persistent, with usually five lobes, or four to eight, overlapping in bud. The regular corolla is hypogynous, monopetalous, with four petals united below, or four to eight lobes, and is bell-shaped or funnel-shaped, wheel-shaped, or salver-shaped, twisted in bud, sometimes persistent. The tube is straight or open, often short,

and the throat is naked, fringed or scaly. There are four to eight stamens, or the same number as the petals, which are epipetalous, alternating with the petals, or corolla-segments. The anther-stalks are slender. The anthers open inwards or outwards when the flower is in bloom. There is a glandular disc. The ovary is one- to two-celled, syncarpous, many-seeded, superior. The style is simple or absent. The stigma is two-lobed or simple, or lamellar. The capsule (septicidal), opens by two valves, and is many-seeded.

The flowers are pollinated by insects.

Hooker recognises three divisions: Chironieæ, including Yellow Wort, Least Yellow Gentian, *Cicendia*, Centaury; Swertieæ, including the Gentians; Menyantheæ, including Bogbean, *Limnanthemum*.

Many of these have bitter tonic properties. The Gentians are cultivated as garden flowers.

### YELLOW-WORT (*Chlora perfoliata*).

The Yellow-wort is unique among British plants in the particular tint of yellow of the flowers (hence *Chlora*). A well-marked feature is the clasping of the stem by the leaf-bases, which are united around the stem, or perfoliate (hence *perfoliata*).

In the British Isles Yellow-wort is found only in England and Ireland, being restricted, where indigenous, to particular soils.

The habitat of this rather local wild flower is dry pastures on chalk and clay, usually in damp places. On the chalk it occurs on chalk grassland both in

the South and in the North, as in Yorkshire. It also occurs in the dwarf willow association and the grassland association in the sand-dune formation. In inland habitats it also occurs in waste places, as on railway banks with other chalk plants, as *Anthyllis*, etc.

Yellow-wort has an erect rosette habit. There are several stems, square in section, from one root. They are erect and rigid, and are, like the leaves, bluish-green. The radical leaves are blunt, inversely ovate to spoon-shaped, and form a tuft or rosette, spreading, whilst those on the stem are in distant pairs, and are ovate, acute, and united below, enveloping the stem.

The flowers are yellow, numerous, in loose, terminal cymes. The corolla is more or less wheel-shaped, with blunt lobes. The eight sepals are filiform, lance-shaped, awl-like. There are eight stamens. The ovary is many-seeded. The style is persistent, and the stigma three-lobed. The capsule ruptures the tube, when ripe.

Yellow-wort is four inches to a foot or more in height. The flowers bloom between June and September. The plant is a herbaceous annual.

The flowers are conspicuous, but do not contain honey. They close up at night and in dull weather. Insects are prevented from climbing up the stem by the perfoliate leaves. The stigma ripens before the anthers, and the flowers are adapted to cross-pollination.

FIG. 25.—YELLOW WORT (*Chlora perfoliata*).
*Messrs. Flatters and Garnett* (Copyright). *See page* 105.

FIG. 26.—FELWORT (*Gentiana Amarella*).
*Messrs. Flatters and Garnett* (Copyright). *See page* 107.

The seeds are blown out of the ripe capsule by the wind.

Great Centaury, More Centaury, Yellow Centaury, Yellow Sanctuary, Yellow-wort are the common names bestowed upon this plant.

CHLORA PERFOLIATA.—*In Fig.* 25 *the perfoliate leaves below each fork of the terminal cymes are well shown, also the filiform sepals.*

### FELWORT (*Gentiana Amarella*).

As a whole the Gentians are distinctly uncommon, and the young botanist or the beginner is generally delighted when he or she is fortunate enough to discover any one of the several British species.

In the British Isles the Felwort or Autumnal Gentian is found in all parts as far north as the Shetlands. It is also found at an altitude of 2100 ft. in Yorkshire. It is native in Scotland and Ireland.

The habitat is dry hilly pastures, and heaths, or calcareous fields. Unlike some plants fond of chalk or limestone Felwort grows on siliceous soils in *Nardus* pasture. When it is found on limestone it is usually on grassland or heath, and on chalk in the same sort of habitat.

Most of the Gentians are erect in habit. The stem is branched, bearing above many flowers. It may be a livid green or purple in colour. The leaves are lance-shaped, or ovate, and stalkless, the radical leaves being oval to spoon-shaped.

The flowers are numerous, often crowded, borne in a loose, leafy, rather oblong panicle. They are of a pale purplish-blue colour. The calyx is five-cleft, with usually equal, narrow to lance-shaped segments, divided to the middle. The tube of the corolla is more or less cylindrical and broad, with a spreading limb, the throat fringed with hairs, with five lobes, longer than the calyx-lobes, ovate or oblong, with no intermediate smaller lobes. The four to five stamens are included and attached to the tube. The style is persistent after the flower fades. The two stigmas are bent back. The capsule, which is stalked or not, opens by two valves septicidally, and is many-seeded. The seeds are surrounded by the placenta.

The Felwort is from 6–12 in. in height. It flowers late in August and September, and is either annual or biennial, and herbaceous.

The flowers are conspicuous, and only open fully in bright sunlight. The tube is very long, being 16–18 mm. in length, but being 6 mm. wide the base can be reached by humble bees and Lepidoptera. The honey lies at the base of the ovary and tube. The stamens form ridges on the tube, and divide it up into compartments. Hairs at the entrance protect the honey from flies and rain, and the flower also shuts in wet weather. The anthers open above, and are below the stigma. Insects touch the latter first, then the anthers.

The seeds are scattered by the wind.

As the second Latin name, used formerly as a

generic name, implies, the plant has bitter properties. This serves as a protection against cattle.

The Felwort is called Baldemoyne, Baldmoney, Bitterwort, Feldwood, Felwort, Fieldwort.

GENTIANA AMARELLA.—*Note in the illustration (Fig.* 26), *the erect habit, also the stalkless, ovate leaves, the loose panicle of flowers, the cylindrical corolla, longer than the calyx.*

## 50. THE JACOB'S LADDER GROUP.

Only one member of the Order Polemoniaceæ is found in the British Isles. There are, however, about two hundred species and eight genera. Most of them are found in temperate N. or W. America, Europe or N. Asia, but some of them are natives of W. S. America, in Chili and Peru. Some are Arctic.

In this group are included the Phloxes of the garden and other cultivated plants. The Order is related to the Convolvulus group.

Most of the species are herbaceous, but some are shrubs, or shrubby below, and include both annual and perennial plants. They are smooth or hairy. The leaves are alternate, or opposite below, entire or divided, devoid of stipules.

The flowers are in terminal cymes, regularly dividing into two branches, or in panicles, or in heads. They are hermaphrodite, regular, or zygomorphic, and most of the flowers are blue or white.

They possess bracteoles in some cases. The calyx is inferior, gamosepalous, with five lobes, or teeth, overlapping or valvate in bud, and persistent. The corolla is regular, gamopetalous, with five lobes, twisted in bud, bell-shaped, funnel-shaped, or plate-shaped, and is more or less perigynous. There are five stamens, which are epipetalous, inserted on the middle of the tube of the corolla, alternating with the petals, usually unequal. The anthers are two-celled. The pollen is blue, more or less rounded, and netted. There is a fleshy disc. The ovary is three-celled (or two- to five-celled). The style is simple, lobed at the tip. There are three linear stigmas, which are rolled back. The capsule is three-celled, and opens by slits by three valves loculicidally. The cells are one- or many-seeded.

The flowers contain honey, and the stigma and anthers ripen separately in the Jacob's Ladder.

The capsule opens to allow the seeds to be wind-scattered.

The plants of this group are of no economic importance, but are largely cultivated as ornamental garden flowers.

### Jacob's Ladder (*Polemonium cœruleum*).

The English name appears to be applied to this plant on account of the pinnate leaves, which resemble the rungs of a ladder. The second name applies to the colour of the flower.

FIG. 27.—JACOB'S LADDER (*Polemonium cæruleum*).
*Messrs. Flatters and Garnett* (Copyright).

*See page* 110.

In the British Isles this plant is found in England and Scotland, and is apparently indigenous in the North Midlands, and North of England. It occurs in native stations in dingles, as in Shropshire, where I have found it with *Impatiens noli-me-tangere*, or Touch-me-not Balsam, and *Elecampane*. Everywhere, however, it is a rare plant.

In a wild state it is found in woods and copses, and streams, and in bushy hilly places, frequently on a chalky soil. When not native it is found as an escape from the garden, where it is a favourite, as an old-fashioned garden flower. I have found it by the wayside, and in waste places as a casual.

The habit is erect. The stem may be smooth, or downy, glandular above, and is angular, hollow, and leafy. The rootstock is short and creeping. The pinnate radical leaves form a dense tuft, the stalk being 6 in. long, with as many as twenty-one leaflets, which are lance-shaped, entire, smooth, and light green in colour.

The alternate stem-leaves are also pinnate, but smaller, with about eight pairs of opposite leaflets and a terminal one, stalkless, ovate, or oblong to lance-shaped, acute.

The flowers are blue or white, numerous, pendulous, terminal, in a corymb or panicle. The calyx is bell-shaped with five oblong, acute lobes. The corolla is bell-shaped with spreading lobes, more or less acute, the tube short, broad and open, the limb five-cleft. The stamens are oblique, the anther-stalks dilated

into hairy scales. The capsule is erect and included in the calyx. The seeds are numerous, laterally flattened on the ventral side, angular, dark brown, elliptical, rough.

The Jacob's Ladder is 1–2 ft. in height. It flowers in June and July, and is a herbaceous perennial.

The anthers are mature before the stigmas. Honey is secreted at the base of the ovary and is concealed by the woolly hairs in the tube. The swollen anther-stalks also protect it. The anthers are ripe before the flower opens. The stigma is longer, and in this stage self-pollination does not occur. But as later, and in wet weather, the flowers droop, the pollen may fall on the stigma and the flower is then self-pollinated.

The seeds are jerked out of the capsule by the wind.

Bluejacket, Charity, Gilliflower, Greek Valerian, Jacob's Ladder, Joseph's Walking-Stick, Ladder to Heaven, Poverty, are the names by which it is known.

POLEMONIUM CŒRULEUM.—*Fig. 27 shows the pinnate stem-leaves, which are alternate, and the pendulous flowers in a loose corymb, with the oblique stamens.*

## 51. THE HOUND'S TONGUE GROUP.

In the Order Boraginaceæ are included a number of beautiful plants. They are related to the Vervain Group, White Dead Nettle Group and Convolvulus Group. There are twelve hundred or more species and eighty-five genera. Members of this group are found

all over the world in tropical as well as temperate climates. The south of Europe, and the Mediterranean area, and Eastern Asia are regions where they especially abound.

Most of the Boraginaceæ are herbaceous plants, but a few are trees and shrubs. They are mainly perennials. Some are stiffly hairy, rough or downy. They possess fleshy roots and rhizomes. The stems are round, not square, in section. The leaves are, as a rule, alternate, entire or wavy. The venation is well-marked. There are no stipules.

The inflorescence is forked, spiked, or racemose, occasionally a scorpioid cyme, usually terminal, sometimes in the axils. The flowers open as the inflorescence unrolls, as in Forget-me-not. They are complete, regular as a rule, hypogynous, with the parts in fives, with or without bracts, and are wheel-shaped, monopetalous or tubular, bell-shaped or salver-shaped. The throat of the corolla may be clothed with hairs or possess folds or ridges. The five lobes are overlapping in bud. The calyx is inferior, persistent, with five lobes or teeth, overlapping in bud or open, and the odd sepal is posterior. There are five stamens, which are epipetalous, of the same number as the corolla-segments, and alternate with them. The filaments are short. The anthers open inwards. The disc is hypogynous or absent. The ovary is deeply four-lobed. The style is simple, inserted between the lobes. The stigma is simple or two-lobed. The fruit is a drupe or consists of

four achenes or nutlets, one-seeded, enclosed within the calyx.

The modes of pollination are interesting. The Lungwort is heterostylic. The fruits are often hooked and dispersed by animals.

The group is divided into four sections in so far as British forms are concerned: Echieæ, including Viper's Bugloss; Anchuseæ, including Borage, Comfrey, Alkanet; Lithospermeæ, including Gromwell, *Mertensia*, Lungwort, Forget-me-not; and Cynoglosseæ, including *Asperugo*, and Hound's Tongue.

Many of the plants in this group have properties of importance. They are mucilaginous and emollient. Purple or brown dyes are yielded by the roots. Some of the plants yield alkalies.

### Viper's Bugloss (*Echium vulgare*).

One of our loveliest wild flowers, Viper's Bugloss is not so common as the common Bugloss, a cornfield plant, though the Latin name here would suggest that it is.

The plant is found in all parts of the British Isles, but is more common in the South, and in Ireland on the East coast. In Scotland it is regarded as an alien or colonist alone. It would appear to be more native on the chalk than elsewhere.

The habitat of Viper's Bugloss is dry places, roadsides, waste places, on light soil, walls, gravel pits, quarries, or where ballast may be found. On the

C. *Edwards.* FIG. 28.—VIPER'S BUGLOSS (*Echium vulgare*). *See page* 114.

C. *Edwards.* FIG. 29.—EVERGREEN ALKANET (*Anchusa sempervirens*). *See page* 116.

chalk it may be found on chalk grassland or pasture, where it is abundant. It is also found on the coast in shingle beach communities.

In habit Viper's Bugloss is erect. The root is spindle-shaped. The stem is erect or ascending, stout, leafy with spreading prickly hairs, unbranched. The radical leaves form a rosette, narrowed below into a stalk, lying on the ground, at length withering. The stem-leaves are linear to lance-shaped, or oblong with a round base, stalkless, acute.

The flowers are in a short cyme, which is curved backwards and lengthens in fruit. The bracts are linear. The flowers are reddish-purple, then bright blue, or rarely white. The five sepals are linear, the calyx longer than the tube of the five-lobed corolla, with an oblique limb. The four stamens are exserted, the fifth included. The nutlets are inserted on the receptacle, and are rough and angular.

The plant is tall, being from 1–3 ft. high. It flowers in June and July, and is a herbaceous annual or biennial.

The conspicuous flowers, all turned one way, contain a large amount of honey, and are attractive to bees and other insects. Muller observed more than 100 insect visitors to this one flower alone. The stamens are attached to the tube just below the wider part. The fifth stamen makes the tube two-chambered as it were, the other four lying in the lower part. When the flower expands the anthers ripen, and the pollen is shed upwards. At this stage

the stigma is not so long as the tube, but it finally overtops the stamens. The flower is thus adapted to cross-pollination.

The nutlets fall, when ripe, near the plant. The plant is protected from cattle by its bristly stem (hence Bugloss).

The name Viper's Bugloss is said to be connected with the spots on the stem, like the spots on a Viper, or with the shape of the nutlets, and for this last reason, the nutlets were used as a cure for snake-bites. Bugloss means ox-tongue.

Blue Bottle, Blue Weed, Wild Borage, Bugloss, Viper's Bugloss, Cat's-Tail, Blue Cat's-Tail, Viper's Grass, Iron-weed, Langdebeef, Our Lord's Flannel, or Our Saviour's Flannel, Snake Flower, Snake's Bugloss, Viper's Herb are names given in various districts to this plant.

ECHIUM VULGARE (*Fig.* 28).—*The long leaves on the stem are linear. The cyme contains numerous flowers, which are stalked, with the anthers exserted.*

### EVERGREEN ALKANET (*Anchusa sempervirens*).

Although not an indigenous plant, the Evergreen Alkanet may be met with in most districts in this country, where it is a wanderer from old gardens, having been formerly used as a medicinal plant (hence *Anchusa*, ancho meaning constrict). The evergreen nature of this species (there are two British species), is one reason, perhaps, for its general occurrence.

This species is found in all parts of the British Isles, where, however, it is rare.

The habitat is roadsides, hedges, especially in Devonshire, and waste places generally, the outskirts of villages, gardens, etc.

The habit is erect, but straggly. The whole plant is rough, like many members of this group, serving them as an effective protection against animals. The root is stout. The stem is unbranched. The leaves are broadly ovate. The lower radical leaves are long-stalked, oblong to ovate, and the stem-leaves are short-stalked, acute.

The flowers are bright blue, in axillary cymes in pairs or short spikes, one-sided, on spreading, slender flower-stalks, 2–3 in. long, with a pair of ovate, lance-shaped bracts below. The calyx is five-cleft, with oval or linear sepals, hairy externally. The straight funnel-shaped or salver-shaped tube of the corolla is short, with five blunt white scales, which close the tube, which is not so long as the limb. The stamens are included. There is a small appendage or ring on the inner margin of the nutlet, which is netted and small.

The plant is 1–2 ft. in height. It is in flower between May and July, and is a herbaceous perennial.

The flowers are conspicuous. The honey is only accessible to bees owing to the narrow opening of the tube, which, however, is not long. The scales protect the honey at the base of the ovary from rain and small flies, and the hairy stem also

impedes the passage of the latter for the same reason.

The flowers are rendered the more conspicuous by the expansion of the limb and by being somewhat crowded. Cross-pollination is favoured.

The nutlets fall, when ripe, near the plant.

The only name given by Britten and Holland to this plant is Pheasant's Eye, applied also to *Adonis autumnalis*.

ANCHUSA SEMPERVIRENS.—*In Fig. 29 it is possible to make out the stiff hairs on the stem. The stem-leaves are broadly-ovate, deeply-veined, shortly-stalked. The flowers can be seen to be in axillary cymes in pairs or short spikes with bracts below.*

### FIELD FORGET-ME-NOT (*Myosotis arvensis*).

Though not possessing so conspicuous a flower as the Marsh or Wood Forget-me-nots, this common species is well known and familiar to all who take that lively interest in wild flowers, for whom these volumes are especially written.

In fact the Field Forget-me-not is found in all parts of the British Isles. In Yorkshire it grows at an altitude of 1200 ft.

The habitat of the Field Forgot-me-not is, as the name implies, fields and woods, cultivated ground, waste places, hedge-banks, bushy places; and on clay and loam it grows in damp oakwoods as well as on neutral grassland, and on a chalk soil on chalk grassland.

*W. E. Mayes.* FIG. 30.—FIELD FORGET-ME-NOT (*Myosotis arvensis*). *See page* 118.

*T. R. Goddard.* FIG. 31.—HOUND'S TONGUE (*Cynoglossum officinale*). *See page* 120.

The habit is erect. On the stem, which is tall but weak, the hairs are spreading. The lower leaves are oblong to inversely ovate and blunt, the stem-leaves oblong, acute.

The flowers are small, blue, in a stalked raceme, with a short bell-shaped calyx, with a few spreading and numerous hooked hairs, cleft half-way, erect, and closed in fruit. The corolla is concave, the tube equal to the limb, the lobes entire, and the flower-stalks are spreading, longer than the calyx. The style is short. The nutlets are brown, bordered, with a keel in fruit.

The plant is 6–18 in. high. It flowers in June onward till August or later. It is a herbaceous perennial.

Though the flowers are not so large as in the Wood Forget-me-not they are bright blue, with yellow spots at the base of the petals, and white radiating bands converging to the centre. There is a nectary at the base of the tube below the ovaries. The yellow spots or processes serve as path-finders, and protect the honey from the rain. Owing to the anthers and stigma being at the same level the flower is likely to be cross-pollinated, for an insect touches the first with one side of its head, the second with the other. There is a broad expansion above the connective of the anther, bent outwards, while the anther is curved inwards. By this arrangement the insect is brushed with pollen as it withdraws its proboscis, and not as it inserts it in the

flower. If there are no visitors self-pollination may occur. Bees and flies are the chief visitors.

The hooked persistent calyx assists in the dispersal of the nutlets by animal agency.

Britten and Holland cite Bird's-eye, Forget-me-not, Blue Mouse-ear as vernacular names.

MYOSOTIS ARVENSIS.—*In Fig.* 30 *note the blunt, oblong, lower leaves, the acute stem-leaves. The terminal racemes are stalked. The flowers are small, and the belt-shaped calyx is easily discernible.*

### HOUND'S TONGUE (*Cynoglossum officinale*).

There appears to be some reason to believe that the English name, a translation of the first scientific name, is due to the lingulate lower leaves, or the texture, like the tongue of a hound. It is, however, not generally a common plant in this country, as the second or specific Latin name would imply. Though compared with the much rarer Green Hound's Tongue this might be said of it.

From Scotland (especially on the east side) southwards it is a not uncommon plant in certain habitats, and occurs also in the south-east of Ireland.

The habitat of the Hound's Tongue is fields, waste places, roadsides, sand dunes by the sea, where it grows in the Marram or Stargrass association. The kitchen middens around old ruins are often colonised by this plant with Deadly Nightshade and Henbane, all fœtid, noxious plants.

The habit is erect. The root is long, tapering, fleshy. The stem is erect, branching above, with rough, appressed hairs, leafy, and very stiff and strong. The radical leaves are long-stalked, long, oblong or spathulate, or lingulate, the stem-leaves linear to oblong or lance-shaped, stalkless, clasping, downy, with soft, appressed hairs.

The flowers are crimson or purplish-red, veined, in several one-sided racemes or cymes. The flower-stalks are bent back. The sepals are broadly lance-shaped, blunt, enlarged in fruit. The corolla is small. The border of the nutlets is thickened and they are flat in front, and burr-like, ovate, with short, hooked spines.

The plant is 1–2 ft. high. It is in flower in June and July, and is a herbaceous biennial.

The flowers are not conspicuous. The honey is protected above by scales which close the mouth of the short tube. The stamens exceed the stigma and are included. The stigma is entire or notched. The fœtid odour of the plant may serve to attract flies.

The nutlets, being provided with hooks, are adapted to dispersal by animal agency.

Hound's Tongue is known also by the names Dog's Tongue, Gipsy Flower, Rose Noble, Scald-head. The name Rose Noble is prevalent in Cheshire. The name Scald-head is applied to the plant in Suffolk.

CYNOGLOSSUM OFFICINALE.—*In Fig.* 31 *the habit of the plant is shown, and the character of the stem-leaves, the one-sided raceme, and hooked spinose fruits.*

## 52. The Convolvulus Group.

The Order Convolvulaceæ is an extensive group, consisting of a thousand species which are included in forty genera. The species are mainly confined to the warm and temperate regions.

In the British Flora are included three species of Convolvulus and three species of Dodder.

These plants are principally perennial or annual herbaceous plants or shrubs, usually twiners, but a few are trees. Some lianes are included in the group, and some are adapted to dry conditions. The Dodders are parasitic climbing plants. Some of the members of the group contain a milky juice. The leaves are usually alternate and stalked. But in Dodder there are no leaves. In a few cases there are stipules.

The inflorescence is a cyme or a raceme, as a rule, with bracts and bracteoles. The flowers are rarely solitary. They are hermaphrodite, regular, hypogynous, with the parts in fives. The calyx is polysepalous, as a rule, inferior, with five distinct sepals, often unequal, the odd sepal posterior, overlapping in bud, persistent. The corolla is gamosepalous or sympetalous, regular, deciduous, hypogynous, tubular, bell-shaped, funnel-shaped, induplicate to valvate, or twisted in bud, with four to five lobes, or sub-entire, or angled. The stamens are five, inserted on the tube, epipetalous on the base of the corolla, alternate with the petals.

The filaments are sometimes unequal, and swollen

at the base. The anthers are arrow-shaped, often twisted after flowering, and open inwards. The pistil is syncarpous and consists of two or more carpels, and the ovary is two to four-celled, situated on a disc. There is a single slender style (or rarely two). There are two or three stigmatic lobes or two styles. The fruit is a capsule, berry, or nut. The seeds are albuminous, and two, four, or six are contained in each capsule with two, three or four cells, with thin partitions.

The flowers are large and brightly coloured, and pollinated by various classes of insects, some by nocturnal Lepidoptera. There are extra-floral nectaries on the leaf-stalk in some foreign types. The flowers secrete honey. The flowers are short-lived, lasting often but a day.

The group includes a few plants with medicinal properties. The Batata (Ipomæa) is the Sweet Potato with tuberous roots, which are edible.

### SMALL BINDWEED (*Convolvulus arvensis*).

In the late summer few plants are more conspicuous than the Field Convolvulus, especially in arable districts, where this plant is common amongst the corn as well as by the wayside.

In all parts of the British Isles, at moderate elevations, this species is frequent. In Derbyshire it ascends above the zone of cultivation, to an altitude of 1200 ft.

The habitat is fields, waste places, pastures, corn-

fields, roadsides, hedges, and cultivated ground generally, where it is associated with Charlock, Shepherd's Purse, Poppies, various types of Speedwell amongst the corn, and other agrestal species.

The habit is that of the twining plant, trailing on the ground, or climbing by some support. The circumnutation or revolution is from right to left, takes two hours and is against the sun. The plant is hairless or downy. The rootstock is slender, creeping and largely subterranean, with long roots. The stems are slender, angular, leafy, twining, often prostrate, numerous, branched and interlacing. The leaves are stalked, arrow-shaped, or spear-shaped, or strap-shaped, entire or wavy, with acute lobes, spreading, or angular.

The flowers are borne on stalks in the axils, two on each stalk, and are white or pink, and variegated, or pink with white bands on four-angled stalks, bent back in fruit. There are two small, linear bracts, low down on the stalk. In the other species these bracts are much larger. The sepals are unequ small, broad, oblong, blunt. The corolla is 1 in. in diameter. The style has narrow to linear lobes. The capsule is two-celled, rounded, with a minute point. The stigma is slender.

The plant is 6–24 in. in height, flowers from June to September, and is a herbaceous perennial.

The flowers are conspicuous, and open from 7 a.m. to 10 p.m. They are sweet-scented. There is honey at the base of the ovary, and five stamens. The

*W. E. Mayes.* FIG. 32.—LESSER BINDWEED (*Convolvulus arvensis*). *See page* 123.

*The Author.* FIG. 33.—LESSER DODDER (*Cuscuta epithymum*) ON FURZE. *See page* 125.

latter spring from the corolla, and divide the tube into as many small apertures. At the base the anther-stalks are united by projections. When ripe the anthers open outwards. The stigmas are longer than the stamens, and an insect touches them first. The ovary bends over after flowering and fertilisation.

The capsule opens and the seeds fall near the plant.

Messrs. Britten and Holland have gathered together the following names applied to this plant: Barbine, Barweed, Bearbind, Bell-bine, Bell-wine, Hedge Bells, Billy-clipper, Common Bind, Bindweed, Small Bindweed, Bide, Wild Convolvulus, Corn-bind, Corn-lily, Devil's Guts, Lap-love, Lily, Lily-bind, Rope-wind, Sheep-bine, Wave-wine, Waywind, Weed-bind, Weed-bine, Wheat-bine, Wind, Wither-wine, With-wind, or With-wine, Small Withiwind.

CONVOLVULUS ARVENSIS.—*The prostrate trailing habit is well shown in Fig. 32. The arrow-shaped leaves, with spreading lobes, are well represented. The stalked flowers in the axils are subtended by two small bracts below. Note the striped petals of the bell-shaped corolla and the central anthers and stigma.*

### LESSER DODDER (*Cuscuta Epithymum*).

The Dodders are unique amongst British plants in being parasitic plants that are leafless and rootless. Willis describes the habit as follows: "The stem twines and is sensitive to contact like a tendril, so that it clasps the support tightly; it rarely makes more than three turns about the same branch of the host.

At the points in close contact with the host suckers are developed which penetrate the tissue of the host, growing into organic union with them, and drawing off all the food materials required by the parasite, which has no green tissue of its own. The seeds of Cuscuta germinate later than those of the host plant; a very short anchorage root is formed and the stem nutates in search of a host; as soon as it has clasped one the root dies away."

The Lesser Dodder is not uncommon in England, and is found in South Scotland, and in Ireland and the Channel Islands.

The habitat is that of the host-plants, Heath, Ling, Gorse, Thyme, etc. The plant grows on heaths as a rule, on a sandy soil.

The stems are slender, twining, reddish. There are no leaves or roots, save in the seedling stage.

The flowers are tinged with red, and in rounded, close, small, compact heads. The sepals are acute, nearly erect, the calyx small. The calyx is less than the corolla. The lobes of the white corolla are spreading, and pointed, as long as the tube, which is cylindrical. The scales are large, toothed, in contact, converging, nearly closing the tube, and as long as the latter. The stamens, as well as the style, project beyond the tube. The anthers are blunt or notched. The capsule is two-celled, the seeds angled.

The plant is sometimes 2 ft. in length. Flowers are to be found in August and September, and the plant is a herbaceous annual.

The flowers being clustered together, and white or cream-coloured, tinged with red, are somewhat conspicuous. They contain honey, which is concealed and secreted at the base of the ovary. The scales in the mouth of the corolla serve to protect the honey. The flowers are homogamous. The anthers and stigma, which are both finally exserted, are ripe at the same time. There would naturally be self-pollination in the absence of insect visitors. If the flowers are visited an insect touches anthers and stigma with opposite sides of its head, so that cross-pollination may be effected. Some flowers are cleistogamic.

The seeds are thrown out of the capsule by the agency of the wind.

Of English names attributed to this plant Britten and Holland enumerate Hailwood, Fairies' Hair, Hellweed, Maiden-hair, Mulberry, Red Tangle.

CUSCUTA EPITHYMUM.—*In Fig.* 33 *the parasitic nature of the Dodder is shown, the plant growing on furze, and also the thread-like stems, and the close, rounded heads of flowers.*

### 53. THE DEADLY NIGHTSHADE GROUP.

There are four genera of the Order Solanaceæ in the British Flora, Thorn-apple, Henbane, Woody Nightshade (two species), Deadly Nightshade. Amongst the exotic types are several plants of some importance economically or garden favourites. The Tea-plant was formerly much planted in this country, and now lingers on the outskirts of many villages.

The Tobacco plant is a member of this Order, and has recently been grown in East Anglia for commercial purposes, but in spite of the relatively dry atmosphere on the east coast the climate is not suitable for the bleaching of the leaves for use. Allied to the last is the garden Petunia. In this group is included Mandragora or the true Mandrake, in place of which Black and White Bryony have been used in this country as counterfeits. Other well-known types are Winter-cherry, Capsicum (Cayenne Pepper), and *Schizanthus*, or Poor Man's Orchid. In the genus *Solanum* are included the Egg plant and the Potato. In the same Order the Tomato or Love-apple is included.

There are over fifteen hundred species included in seventy-two genera. The members of the group flourish in the temperate and tropical regions. A large number are natives of Central and South America. In the Old World only the Solanaceæ are found.

They are mainly herbaceous perennials, or shrubs, or rarely small and soft-wooded trees. The leaves are alternate in the vegetative part, or in pairs in the inflorescence, but they may be more or less opposite, and are lobed or pinnate. There are no stipules, but a small leaf may occur at the base of the other leaves.

The inflorescence is usually a cyme, but the flowers may be solitary. They are regular or sometimes zygomorphic. The calyx is inferior, five-partite, and

persistent, and the segment are lobes or teeth. The calyx is frequently enlarged in fruit. The corolla is hypogynous, five-partite, monopetalous, wheel-shaped, or bell-shaped, salver-shaped, sometimes two-lipped, overlapping, folded or twisted in bud. There are five stamens, which are short, epipetalous, of the same number as the petals and alternating with them, rarely unequal, and in irregular flowers not equal in number to the petals. The anthers are connivent or cohering by the tip. They open inwards. There is an annular disc. The ovary is superior, two to four-celled, the style is simple, the stigma two-lobed or simple. The fruit is a many-seeded capsule or berry.

The flowers being conspicuous are adapted to insect visits.

The group is allied to the Convolvulus group and to the Figwort group. Some of the plants are medicinal, being narcotic, tonic, stimulant in principle.

### Henbane (*Hyoscyamus niger*).

Amongst British plants the Henbane is unique in the peculiar markings of the corolla, which are only paralleled by exotic genera. Like other members of the group it is a poisonous plant with a peculiarly nauseous odour.

Henbane is found in all parts of the British Isles, but is doubtfully native in Scotland. It occurs in

Ireland and the Channel Islands. The distribution no doubt depends largely in many cases upon its former (and to some extent present) use in medicine.

The habitat is waste places, sandy stony ground, roadsides. Henbane appears to be more common on chalky ground, like other members of the group (as Black Nightshade, or Solanum, and Deadly Nightshade), or by the sea. I have seen it on kitchen-middens and in old limestone quarries, and it grows near granaries and other kindred gathering-grounds for casuals.

The habit is erect. The stem is stout, round in section, and branched. The whole plant is clammy, with soft, glandular hairs. The radical leaves are stalked, ovate. The stem-leaves are oblong, clasping, with several lobes, and a wavy margin, or sinuate; or the leaf may be nearly divided to the base.

The flowers are in two ranks, and nearly stalkless or shortly stalked, in the axils below, the upper sessile, in a spike, one-sided, recurved before flowering. They are lurid yellow, with dark purple veins and a darker centre, which are sometimes wanting. The calyx is five-toothed, with broad prickly lobes, with an ovoid tube, and a more or less cylindrical limb, short in flower, enlarged in fruit and persistent. The lobes of the corolla are broad, nearly equal. The anthers are purple. The capsules are erect, two-celled, with many seeds, and membranous.

The plant is 1–3 ft. in height. It flowers between June and September, and is a herbaceous biennial.

*The Author.* FIG. 34.—HENBANE (*Hyoscyamus niger*). *See page* 129.

*W. E. Mayes.* FIG. 35.—BLACK BITTERSWEET (*Solanum nigrum*). *See page* 131.

The flowers are conspicuous and large, the veins serving as honey-guides. Honey is secreted at the base of the ovary. At first the stigma is above the stamens, but with the lengthening of the tube they are later on a level, and ripen simultaneously, so that in the absence of insect visitors self-pollination can occur. The flower is adapted to humble bees. Some terminal flowers are cleistogamic.

The calyx is persistent, and the seeds are jerked out of the fruit by the wind.

According to the 'Dictionary of Plant Names' the names Belene, Brosewort, Chenile, Hen-bell, Henkam, Loaves-of-bread, Stinking Roger have been applied to the plant. The plant, with opium and other plants, formed the drug Dwale, which was used formerly as an opiate. It is still used as a narcotic.

HYOSCYAMUS NIGER.—*Fig.* 34 *shows the broad, sinuate stem-leaves, and the two-ranked flowers, with veined petals.*

### BLACK BITTERSWEET (*Solanum nigrum*).

Whilst the common Woody Nightshade is a climbing plant, this species is erect in habit. The flowers of the latter are white or cream colour, those of the former violet, each, however, having the conspicuous yellow centre formed by the cone of anthers.

In the British Isles the Black Bittersweet or Solanum is found in all parts, but nowhere abundantly. In Scotland and Ireland, where it is local, it is

regarded as a casual. It has been observed in the Channel Islands.

The habitat is waste places, or cultivated ground generally. Black Bittersweet is not uncommon in allotment gardens. I have seen it growing on the chalk in the Eastern Counties about the borders of a heath, adjacent to old quarries. It is found also elsewhere on the chalk with Deadly Nightshade.

As noted, the habit is erect. The branches of the stem are spreading, and the angles are swollen, the whole plant smooth as a rule. The leaves are ovate to rhomboid, with a wavy border, or toothed, and stalked.

Borne in an umbel-like, small, lateral cyme, the flowers are few, white, drooping, on short stalks. The calyx-lobes are broad and blunt. The corolla has the segments fringed with hairs and bent back. The berries are small, round, black as a rule, or green, yellow, or reddish, and the stalks are thicker above.

Sometimes the plant is 2 ft. in height, but usually about 1 ft. The flowers are in bloom in June onward to November. The plant is a herbaceous annual.

The flowers are conspicuous, the yellow anthers rendering them the more so. In the allied Woody Nightshade, there are "sham nectaries," as Müller terms them, at the base of the flower, which may be pierced and sucked by insects. The anthers and stigma ripen at the same time, and, if insects do not visit the flower, there will, as a rule, be self-pollination. The flowers droop and close at night.

The fruits are berries which are dispersed by birds which reject the seeds as in the case of other fleshy fruits, whilst feeding on the soft pulpy portion.

Not being a well-known plant, there are few English names. Britten and Holland have, however, collected together the following: Duscle, Garden Nightshade, Hound's-berry, Mixplenton, Morel, Petty Morel.

In former days the plant was regarded as a cure for canker, dropsy, skin complaints. The berries are poisonous.

SOLANUM NIGRUM.—*In Fig.* 35 *note the ovate leaves with a wavy border; also the umbel-like cymes on short stalks, and drooping flowers, placed half-way between successive leaves.*

### DEADLY NIGHTSHADE (*Atropa Belladonna*).

Derived from the Greek for one of the Fates who cut the thread of Life, the first Latin name applied to this plant is the basis of the first English name, and has reference to the poisonous character. The second Latin name is explained as due to the fact that ladies in Italy used the juice to brighten their eyes, or enlarge their pupils, hence Belladonna.

Deadly Nightshade is found throughout Great Britain, and in Ireland and the Channel Islands. In Scotland it is only found near houses, as is often the case in England, where it occurs near ruins.

The habitat is waste places, woods, on chalk, where

it is probably native, and chalk scrub, with Woody Nightshade and Black Solanum. It occurs in old quarries and in parks, and around ruins, and other places where it is dispersed by artificial agency.

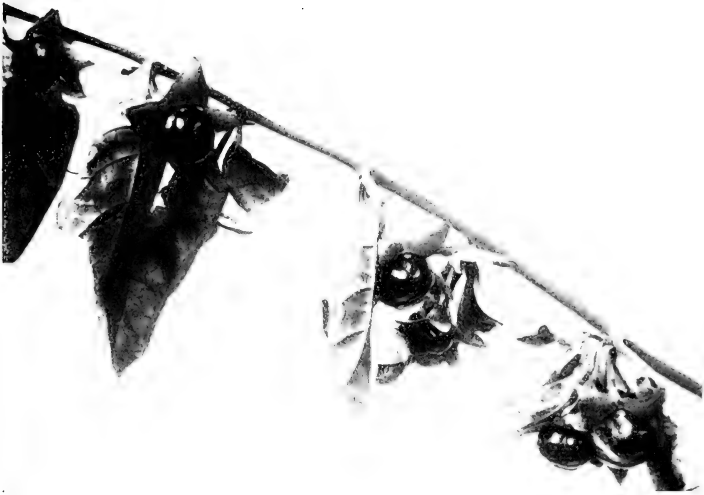
The habit is erect, branching. The plant is smooth, glandular, or downy. The rootstock is stout, fleshy and stoloniferous. The stem is stout and herbaceous. The leaves are stalked, large, in unequal pairs, ovate, entire, a smaller one arising from the axil.

The flowers are axillary, solitary, borne on short flower-stalks. They are lurid purple, greenish below, drooping. The sepals are broadly ovate. The five corolla-segments are broad and short, spreading, blunt, nearly equal. The anther-stalks are distinct, nearly equal, with the anthers included, and pale. The fruit is a round, large, violet-black berry, obscurely two-lobed.

The plant is 2–3 ft. in height. It is in flower in June, July, and August, and the plant is a herbaceous perennial.

The flowers contain honey secreted at the base of the ovary, which is protected by the drooping habit and hairs on the stamens. The stigma projects further than the stamens. The stigma ripens before the anthers, as soon as the flower opens. At this stage the anthers are immature, and the stalks are geniculate, but they lengthen later, though they never exceed the stigma, so that there is not much chance of the plant being self-pollinated. The flowers are adapted to humble bees.

The berries are dispersed by birds.



*The Author.* FIG. 36.—DEADLY NIGHTSHADE (*Atropa Belladonna*). *See page* 133.

*B. Hanley.* FIG. 37.—GREAT PLANTAIN (*Plantago major*). *See page* 137.

The names bestowed upon the plant and collected by the authors of the 'Dictionary of Plant Names' are: Banewort, Belladonna, Naughty Man's Cherry, Daft-berries, Deadly Nightshade, Death's Herb, Dwale, Deadly Dwale, Dway-berries, Jacob's Ladder, Mad, Manicon, Mekilwort, Great Morel, Sleeping Nightshade.

The plant is poisonous, and formed part of the drug Dwale.

ATROPA BELLADONNA.—*Fig. 36 shows the glossy, black berries, which are round, and borne in the axils, shortly-stalked, and solitary.*

### 54. THE PLANTAIN GROUP.

In the Order Plantaginaceæ there are about two hundred species included in three genera. They are natives of temperate regions, but some are cosmopolitan. The British plants include the Plantains and Shoreweed. These plants are annual or perennial, and herbaceous.

The plants are usually rosette plants and scapigerous. The leaves are mainly radical, in tufts, or spreading. The veins are parallel. Stem-leaves are unusual, and either opposite or alternate. The leaves are stalkless, without stipules.

Flowers are borne in heads or spikes, and are not large, being green, hermaphrodite, unisexual in Shoreweed, regular, without bracteoles.

The calyx is four-partite, with persistent sepals,

overlapping in bud. The corolla is membranous, chaffy, with four spreading lobes, hypogynous, salver-shaped, the tube cylindrical. The four stamens are epipetalous, inserted on the tube, but in Shoreweed hypogynous, alternating with the petals, the filaments slender, bent inwards in bud, pendulous in flower, and persistent. The anthers are large and versatile, lightly attached, and soon fall. The pollen is abundant and powdery. The ovary is two- to four-celled, with many ovules in each cell. The style is simple and long, slender, with two lines of stigmatic hairs. The fruit is a capsule, opening transversely, or indehiscent, one- (or more) seeded. It may be a nut, with the calyx persistent, as in Shoreweed.

The flowers are adapted to pollination by the wind. The capsules are adapted to the dispersal of the seeds by the wind.

The flowers are regarded as reduced from the type found in the Figwort group in Veronica. They are also related to Labiatæ.

From the genus *Littorella* the genus *Plantago* differs in that the latter has hermaphrodite flowers in terminal heads or spikes, whereas in the former the flowers are unisexual, and the plant is monœcious, the flowers solitary or two together, the males being stalked, the females sessile among the leaves.

### GREAT PLANTAIN (*Plantago major*).

Waybread is another name for the Plantain, and this describes the fact that this plant seems to have a predilection for the highway.

In the British Isles the Great Plantain is found in all parts, and in Northumberland grows at an altitude of 2000 ft. It is, in fact, everywhere an abundant plant in Great Britain.

In every field where there is a manure heap or hayrick the Great Plantain will be found. The habitat is fields, pastures, roadsides, waste places. This plant is a lover of open ground, and for this reason also grows on arable land, and in gardens, at the base of walls, amongst stones in a paved causeway, etc. In cornfields it becomes variable.

The plant is the largest species amongst British types. It has the rosette habit. There is a short, blunt, stout rootstock. The leaves are broad, ovate, or oval, with a broad grooved stalk, and with short irregular teeth, or entire. They are prostrate or erect. The ribs are strong, usually seven, prominent, parallel, and meet together at the base.

The flowers are green, borne on a long scape, with a stalk, which is much longer than the leaves. The flowers are sessile, and the inflorescence is thus a spike. The sepals are green, with a membranous border, and bluntly keeled. The tube of the corolla is smooth. The anther-stalks are short, but the stamens exceed the corolla, and the anthers

are purple, or reddish-brown. The capsule is two-celled, with four to eight seeds in each cell, which are rough and black.

In height the plant is sometimes 9 in. It flowers from May to September, and is a herbaceous perennial.

Like other Plantains the flowers are adapted to wind-pollination. The anthers mature after the stigma as in most flowers of this type. The stamens are long and flexible, the stigmas feathery, and last a long time. The pollen is set free by a very small aperture and the stamens must be violently shaken to set it free, opening above. Pollen is abundant and insects visit the flowers to obtain it.

When ripe the capsules open, dispersing the seeds, when they are blown away by the wind to a distance.

The plant is known by the names Bent, Bird-seed, Bird's Meat, Broad Leaf, Canary-seed, Carl-doddie, Curl-doddy, Ripple Girs, Great Way-brede, Healing Blade, Kemps, Lamb's Foot, Plant, Plantain. Great Plantain, Rat-tail, Slan-las, Warba Leaves, Wabert-leaf, Wayberan-leaf, Waybread, Wayfrom, Wayside Bread, Weybred, Wibrow, Wybrow.

The seeds have been used as bird-seed.

PLANTAGO MAJOR.—*In the illustration* (*Fig.* 37) *the rosette habit of the plant is shown, with the long-stalked, broad, ovate leaves, and the long scape, with spike-like inflorescence.*

## 55. The Figwort Group.

In the Order Scrophulariaceæ are included amongst British plants the Mulleins, Toadflaxes, Snapdragons, Figworts, Musk, Mudwort, Sibthorpia, Foxglove, Speedwells, Bartsias, Eyebrights, Yellowrattles, Red-rattles, Cow-wheats, and Tooth-wort. Amongst exotic types are the *Bignonia*, *Acanthus*, *Catalpa*, *Gesneria*, *Gloxinia*, *Ruellia*, which are frequently grown in hot-houses in this country.

The group includes about two thousand species and there are some one hundred and eighty genera. They are cosmopolitan in distribution, being found in the Arctic regions as well as in the Tropics, but their principal home is the temperate regions.

A well-marked character of the group is the two-lipped or personate corolla, whilst other features are the paired stamens, and the many-seeded cells in the capsule. The affinities of the group are with the Broom Rape group and the Deadly Nightshade group.

The majority of the species are herbaceous. Some are, however, shrubs or undershrubs and a few are trees. The leaves are opposite below, alternate above, or sometimes all opposite, or alternate or whorled. Usually there are no stipules, but they occur in some cases. A few are climbing plants, a minority, as Mudwort, aquatic. Whilst most are hygrophilous a few exotic types are xerophilous. The group includes numerous hemiparasites as *Bartsia*, Eye-bright, etc.

The inflorescence is a raceme or spike, or a cyme.

In a few cases the flowers are solitary. The flowers are usually irregular, sub-regular in the Mulleins, hermaphrodite, and the flower-stalks bear two bracts in the forks. The calyx is gamosepalous, usually persistent in fruit, inferior, with five lobes or teeth, or fewer, or unequal. The corolla is hypogynous, gamopetalous, irregular, the limb usually two-lipped or nearly regular, with four to five (or more) lobes, overlapping in bud, or more or less valvate in bud. The stamens are normally didynamous, epipetalous, in pairs, four, or two or five, as in *Verbascum*, inserted on the corolla-tube, with a rudimentary staminode or posterior stamen. There is an annular glandular honey-disc below the ovary. The ovary is superior two-celled, many-seeded. The style is terminal, simple, or bilobed. The stigma is pinheaded or bilobed. The persistent calyx envelops the fruit, which is a capsule (with different modes of dehiscence), or a berry. The seeds are small and numerous.

The flowers are adapted in various ways to insects, and some are wasp flowers.

The group includes many plants with medicinal properties, *Digitalis*, for instance, being included in the *Materia medica*.

In this group are included also many garden flowers such as the *Calceolaria*, *Pentestemon*, Musk, etc.

### Black Mullein (*Verbascum nigrum*).

As a general rule the Mulleins are known to the non-botanical public only from their occurrence in

*W. E. Mayes.* FIG. 38.—BLACK MULLEIN (*Verbascum nigrum*). *See page* 140.

*W. E. Mayes.* FIG. 39.—CREEPING TOADFLAX (*Linaria repens*). *See page* 142.

the garden, where the Common Mullein is a frequent and favourite flower. And it is perhaps owing to this last fact that the different species are found in a wild state (or rather semi-naturalised state), in waste places adjacent to towns and villages.

This species is apparently native in some parts of the Midlands and the South of England, and in the North of England and South of Scotland it is perhaps only naturalised. It is not found in Ireland.

The Black Mullein is found on banks and waysides, especially on a gravelly soil, or in fields and waste places, being like other species often an escape from gardens in the areas indicated above. The most native habit is grass-land on a chalk soil, where it grows with some other species.

The habit is tall and pyramidal. The stem has a few long, distant, woolly hairs, and is angular. The radical leaves are stalked and not decurrent, egg-shaped to oblong, or lance-shaped, or cordate, doubly scalloped. The stem-leaves are stalked, except the upper ones, ovate to heart-shaped. They are not white below, but stellately downy, nearly hairless above.

The flowers are borne in a tall, erect, slender raceme—simple, or but little branched—or clustered in a sub-simple, spike-like panicle. They are bright yellow. The ultimate flower-stalks are twice as long as the calyx. There are many flowers within each bract. The sepals are small, tomentose, and lance-shaped. The anthers are not decurrent, the stamens being

equal, with purple hairs on the stalks. The capsule is many-seeded, opening septicidally, by two valves. The seeds are brown, ridged, and pitted, and very light.

The plant is 2–3 ft. high. The period of flowering extends from June to October. The plant is a herbaceous biennial like the rest of the species.

Very little honey is secreted by the flower. The flowers, however, are conspicuous, and the purple hairs on the anther-stalks assist in this. The upper stamen is shorter than the two lower. The anthers open externally. The pistil is bent downwards so that insects touch the stigma before the stamens, though it is not so long as the lower pair. Self-pollination, which may occur in the absence of insect visitors, does not appear to be effective.

The seeds are dispersed by the wind, being blown out of the capsule.

The name Verbascum from *Barbascum*, Latin, *barba*, a beard, refers to the downy character of some species. Black Mullein is the only name.

VERBASCUM NIGRUM.—*In Fig.* 38 *note that the leaves are stalked, in other species being usually sessile. Note also the long raceme with clustered flowers, which are long-stalked.*

## CREEPING TOADFLAX (*Linaria repens*).

All the Toadflaxes are beautiful wild flowers, and the one under notice is not less so than the rest, with its

choice, pale lilac blooms, besides which the graceful creeping habit lends to it additional elegance.

In the British Isles it is not a common plant, where indigenous. It is, in fact, rare in England and in Ireland, being only naturalised in Scotland. It is found in the Channel Islands.

The habitat is stony places, especially chalk districts, and apparently especially near the sea, where the chalk extends in several areas. As a casual, it is found in waste places. It is very common on the banks of the Great Western Railway, and other lines. About Reading it grows along with the Common and Purple Toadflax, which last two hybridise. I have recently noted its occurrence on railway banks in Leicestershire, where it is now firmly established.

The habit is creeping (hence *repens*), or prostrate, then ascending. The rootstock is slender but woody. The stems are erect, in some cases branched, and leafy. There are no hairs on the stem or other parts. The leaves are crowded or scattered above, or at the base in whorls. They are linear to lance-shaped.

The flowers are in a long, terminal raceme, with very small bracts. They are small, sweet-scented, white, with lilac or blue veins. The sepals are lance-shaped, as long as the spur, but not so long as the capsule. The corolla has the spur nearly parallel with the tube, and blunt. The spur is short and conical. The capsule is broad with flattened margins. The seeds are angled, with transverse, elevated wrinkles.

The plant is about a foot in height. It flowers rather late, between July and September. It is a herbaceous perennial.

The floral structure indicates that the plant is adapted to long-lipped insects, none but these being able to reach the honey in the spur, which is not, however, so long as in the Common Toadflax. The conspicuousness of the flowers with the radiating lines or honey-guides, the sweet scent of the flowers, and the honey, render the Creeping Toadflax attractive to insects, so that in most cases it is probable that the flowers are cross-pollinated.

The capsule contains many seeds, which are wind-dispersed, and the ridged surface facilitates this mode of dispersal.

Except that the plant is suited to the flower garden there are no properties possessed by it that render it of any economic importance.

LINARIA REPENS.—*Fig. 39 shows the habit of the plant, with crowded leaves, whorled, linear to lance-shaped; also the long raceme of flowers, and short bracts.*

### KNOTTED FIGWORT (*Scrophularia nodosa*).

From the common Water Betony Knotted Figwort differs in the absence of wings to the stem, the more triangular acute leaves, the narrow border to the sepals, and the notched scale. Besides these differences the rootstock is nodose or tuberous (hence *nodosa*); and it was from this characteristic that in a

*W. E. Mayes.* FIG. 40.—KNOTTED FIGWORT (*Scrophularia nodosa*). *See page* 144.

FIG. 41.—MUSK OR MONKEY FLOWER (*Mimulus luteus*).
*Messrs. Flatters and Garnett* (Copyright). *See page* 147.

past age the fanciful connected the plant with the disease called scrofula, regarding the rhizome as a remedy for the disease (hence Scrophularia, which gives the name to the Order).

Knotted Figwort is a common plant in the British Isles, extending to the north of Scotland, and occurring in Ireland and the Channel Islands. In Yorkshire it is found at an altitude of 1500 ft., or above the wheat zone.

The habitat is shady places, especially moist woods, copses, hedges and thickets. The plant is found in damp oakwoods on clay and loam, also on sandy soil in dry oakwoods in more damp situations, as well as in the marsh formation.

The habit is erect. The rootstock is short, nodose, tuberous, with many small tubers or knots. The stem is simple, square, or four-angled, the angles acute. The leaves are shortly stalked, dark green (lighter in Water Betony), ovate or triangular to heart-shaped, with double, acute, coarse teeth or scalloped, and the lowest teeth are largest. The veins are prominent.

The flowers are borne in a loose cyme, or pyramidal or oblong panicle, with a few glandular hairs. There are small, acute, linear to lance-shaped bracts, the lower ones leafy. The flowers are greenish purple, lurid, but are sometimes pale green. The sepals are blunt, round to ovate, and have a very membranous, narrow border. The throat of the corolla is not narrowed, the upper lobes being longer than those at

the side, the tube twice as long as the calyx. The upper lip is darker in colour. There are four stamens, which are included, and the fifth is a wedge-shaped staminode or scale and notched. The capsule is broadly ovoid, with a narrow point. The seeds are brown with a rough surface.

In height Knotted Figwort varies from 2–6 ft. It flowers from June to September, and is a herbaceous perennial, largely propagated by the tubers.

It is considered that the colour of the flowers is attractive to wasps, and also resembles their colouring. The stigma ripens first, and is receptive for two days, when it projects. The anthers then open and shed pollen, lasting two days. After the stigma has received pollen it bends down. The upper flowers open first. The younger flowers receive pollen brought by insects from older flowers of another plant. The flowers have a peculiar, somewhat unpleasant scent, also perhaps attractive to wasps.

The capsule opens by valves and the seeds are dispersed by the wind.

The names which Britten and Holland cite as applicable to this plant are Bore-tree, Brennet, Brown Net, Stinking Christopher, Cutfinger, Figwort, Hastie Roger, Kernelwort, Murrain-grass, Great Pilewort, Poor Man's Salve, Rose Noble, Stinking Roger, Throatwort.

The reputed medicinal properties of this plant have been mentioned above.

SCROPHULARIA NODOSA.—*In Fig.* 40 *note the oppo-*

*site, stalked, cordate leaves, with teeth, coarser below; also the loose pyramidal panicle.*

Musk or Monkey Flower (*Mimulus luteus*).

Like the Ivy-leaved Toadflax and Canadian Waterweed the Monkey Flower, a species of Musk, is a native of North America, which has become introduced into this country within more or less recent times. There are some older American types, such as the Pipewort and the Blue-eyed Rushes, which have been established in these Islands for a much longer period. The first Latin name refers to the form of the corolla, like an ape or a monkey, the second to the colour of the flowers.

In spite of its comparatively recent introduction this plant is found in all parts of the British Isles.

The Monkey flower is a moisture-loving plant, and occurs in moist situations, as in boggy places with Marsh Forget-me-not, Marsh Red Rattle, Bog Stitchwort, various types of rushes and sedges, etc. Riversides, streamsides, marshy places, generally in lowland areas, but sometimes at higher elevations, are the places in which to seek for this elegant alien.

The habit is sub-erect, prostrate, then ascending. The root-stock is creeping. The plant is hairless or glandular and downy. There are numerous creeping, barren stems, and a few erect flowering shoots. The stems are stout, round in section, and fistular. The leaves are ovate, rounded, with seven to nine

veins, the lower leaves are stalked, with lobes on the leaf-stalk, the upper clasp the stem, and are stalkless. They are coarsely toothed.

The flowers are yellow, and sometimes have crimson spots on the throat or mouth of the tube, with a few on the lobes. The calyx is tubular, with five teeth, and five-angled. The corolla is two-lipped. The upper lip is erect or turned back with two lobes, the lower one is spreading and three-lobed. There are four stamens. The stigma has two equal lamellæ. The capsule is two-valved, and contains many small, oblong seeds.

The plant is 1–2 ft. high, flowering in July and August, and is a herbaceous perennial.

The flower is conspicuous, and the spots may serve as an attraction to insects. The flowers are adapted to bees. The stigma and anthers ripen simultaneously. As the stigma lies above the anthers and projects it is likely to be touched first by an insect visitor. The structure of the stigma is peculiar, there being two plates which are sensitive. These enclose pollen once it is deposited, and then re-open.

The small seeds are wind-dispersed when the capsule opens by the valves.

MIMULUS LUTEUS.—*In Fig.* 41 *note the ovate upper leaves, clasping the stem, the flower with crimson spots on the throat of the tube, and the two-lipped corolla and tubular calyx.*

CORNISH MONEYWORT OR SIBTHORPIA (*Sibthorpia europæa*).

This somewhat local plant is one of the creeping or trailing type of the Figwort family, with a graceful habit.

It is a southern species, which is found in the south-west of England and Wales, the South of Ireland and the Channel Islands. In South Europe it is found in the Mediterranean, as well as on the Western or Atlantic coasts.

The habitat is moist shady banks and other places in the areas cited. It is thus more or less a shade plant or ombrophile, and is a type of those plants that are of woodland origin, as opposed to the plants that seek the light of the sun and are photophilous.

The habit is creeping or trailing. The stems are thread-like, slender, prostrate, with limp, jointed hairs. The stems root at the nodes, giving rise to adventitious roots as they are called, which are common to most plants with this habit. The leaves are alternate, small, shortly stalked, rounded, kidney-shaped, or five- to seven-lobed, heart-shaped at the base, scalloped, hairy, membranous. The lobes are broad, rounded, and notched.

The flowers are very small, solitary, pink, borne on short stalks in the axils. The calyx is four- to five-lobed, the corolla is five-lobed, the two upper, smaller lobes yellow, the three lower broader. There are four stamens. The stigma is pin-headed.

The capsule is membranous, very small, flattened at the margin, two-valved. The seeds are convex on the back.

The plant is 6–12 in. in length, and flowers in July and August, being a herbaceous perennial.

The floral mechanism indicates that the plant is adapted to insects. The size of the flowers is small, but they are conspicuous, and the stigma and anthers are placed so that an insect visitor touches the former first, favouring cross-pollination.

The seeds are dispersed close to the plant.

Messrs. Britten and Holland cite the following names for this plant: Bastard Chickweed, Cornish Money-wort, Moneywort, Penny Pies, Pennywort.

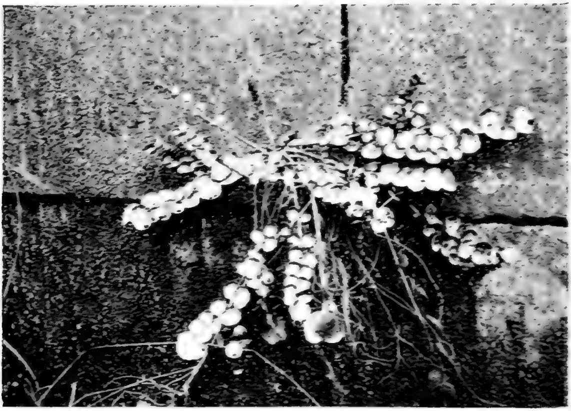
SIBTHORPIA EUROPŒA.—*Note in the illustration (Fig. 42) the tufted habit. Several of the leaves are as yet not fully expanded. The leaves are kidney-shaped or orbicular.*

### FOXGLOVE (*Digitalis purpurea*).

Few wild flowers are more popular than the Foxglove, which is a favourite in the flower-garden, and figures largely in plant folk-lore, being one of the fairy plants, the bells or corollas being variously supposed to have been used as caps for the little folk or for thimbles.

The plant is found throughout the British Isles, growing everywhere except in areas where the rocks are calcareous, being a calcifuge.

The habitat is usually a shady one, such as wood-



*C. Edwards.* FIG. 42.—CORNISH MONEYWORT (*Sibthorpia europaea*). *See page* 149.

*B. Hanley.* FIG. 43.—FOXGLOVE (*Digitalis purpurea*). *See page* 150.

lands, copses, dry banks, on stony, sandy soil, hedge-banks, roadsides, hilly waste places, quarries. On sandy soil it grows in the dry sandy oakwood, forming societies or small groups. Being abundant in the west it is also native on siliceous soils in the sessile oakwoods.

The habit is erect, pyramidal. The whole plant is glandular, downy and hoary. The stem is erect, simple, or with few branches, stout. The radical leaves are long-stalked, ovate, lance-shaped, scalloped, downy, rough, with prominent veins. The upper stem-leaves are without stalks.

The flowers are in a one-sided raceme, pendulous, numerous. There are leafy bracts. The ultimate flower-stalks are short. The flowers are large, more than an inch long, purple or pink, with darker spots and blotches, and occasionally white. The five lobes of the calyx are unequal, oblong to lance-shaped. The corolla is irregularly bell-shaped, with the four to five lobes fringed with hairs, the lower two longer. The capsule is longer than the calyx and ovoid. The seeds are angled, small.

The plant is 2–4 ft. in height, or occasionally as much as 6 ft. or more. The flowers bloom between June and August, and the plant is a herbaceous biennial or perennial.

Honey is secreted at the base of the ovary. By the pendulous position of the flowers the honey is protected from the rain, and from creeping insects by the hairs in the corolla. The flowers are so large

that humble bees can enter. The anthers and stigma are arranged on the upper side of the corolla, and the former ripen first. There are two long and two short stamens, in pairs, longer than the stigma at first. There is an equal chance of cross- and self-pollination, for if all the pollen has not fallen when the stigma is mature, some may fall on the stigma, otherwise insects normally cross-pollinate the flower.

The seeds are dispersed by the wind.

There are a great many vernacular names for this plant, of which Britten and Holland give a large number, such as Dead Man's Bell, Blob, Bloody Finger, Cottagers, Cowflop, Dead Men's Bellows, Flap Dock, Dragon's Mouth, Fairies' Petticoats, Fairy Bells, Fairy Cap, Fairy Glove, Fairy Thimbles, Fairy Weed, Finger-flower, Finger-root, Flop-a-Dock, Flop Poppy, Flowster-docken, Fox-fingers, Foxtree, Goose Flops, Lady Glove, Lady's Thimble, Lusmore, Pop-glove, Snoxuns, Throatwort, etc.

The plant yields a narcotic drug, and is included in the *Materia medica*. It is highly poisonous.

DIGITALIS PURPUREA.—*In Fig.* 43 *note the long, tall raceme, one-sided, with pendulous, bell-like flowers, well-protected from the rain.*

GERMANDER SPEEDWELL (*Veronica Chamædrys*).

The Bird's Eye of the countryman, there is no more charming wild flower than this in early spring, its clear blue flowers matching well the colour of the April skies; and, seen as it may be peeping out of

*B. Hanley.* FIG. 44.—GERMANDER SPEEDWELL (*Veronica Chamædrys*). *See page* 152.

FIG. 45.—COW-WHEAT (*Melampyrum pratense*).
*Messrs. Flatters and Garnett* (Copyright). *See page* 154.

the wayside bank, its grace and beauty are evident to every passer-by.

The Germander Speedwell is everywhere abundant in the British Isles, and also in the Channel Islands. It is found at an altitude of 2700 ft. in the Highlands.

The habitat is woods, copses, pastures, fields, hedgebanks, roadsides, banks. On clays and loams the plant occurs in the damp oakwood, as well as on neutral grass-land in the open. In limestone districts it is found on limestone grass-land, as well as on alluvial silt in the marsh formation.

The habit is prostrate, then erect. The stem is slender, creeping with slender, ascending branches. There is a row of hairs on opposite sides of the stem in each internode. The leaves are in pairs, on short stalks, ovate to heart-shaped, scalloped, coarsely-toothed, hairy.

The flowers are in axillary, loose, long racemes with linear bracts, which are not so long as the ultimate flower-stalks, the main flower-stalks slender, ascending in fruit. The flowers are large, numerous, bright blue. The calyx is four-cleft, the sepals linear to lance-shaped, acute. The corolla may be pink in colour. The capsule is flat, inversely heart-shaped, broader than long, with a deep notch, downy, fringed with hairs, not so long as the calyx.

In height the plant is 6–20 in., usually about 8 in. The flowers are in bloom in May or earlier, up to June or later. The plant is a herbaceous perennial.

The flowers are conspicuous and numerous, and

adapted to insect visitors, chiefly flies. Lines on the corolla serve as honey-guides.

Honey is secreted at the base of the ovary, and is protected by hairs. The stamens and stigma ripen together. The flowers open between 5 and 6 a.m., and close between 5 and 6 p.m. The stamens are spreading, whilst the central stigma is erect. The smallest petal serves as an alighting place for the fly, which clings to the long stamens and is dusted with pollen.

The capsule opens by valves, the seeds, few in number, falling near the plant.

A popular plant, such as this, has many vernacular names as Angel's-eyes, Billy Bright-eye, Bird's-eye, Blue Eye, Blewart, Blind Flower, Blue Stars, Cat's Eyes, Deil's Flower, Eyebright, Forget-me-not, Lady's Thimble, Love-me-not, Poor Man's Tea, Remember Me, Wish-me-well.

VERONICA CHAMÆDRYS.—*Fig.* 44 *shows the opposite rows of hairs on the stem. The petals are seen to be unequal, one being much smaller than the others. The stamens are seen in several flowers projecting a long distance.*

### COW-WHEAT (*Melampyrum pratense*).

This is one of those plants that have been termed hemiparasites owing to the fact that they live upon the roots of other plants, grasses as a rule, forming suckers, where the host and parasite are connected. In speaking of the Eyebright, which this plant re-

sembles in its hemiparasitic character, Dr. Von Wettstein says, " The formation of the suckers occurs in spring, the absorption of organic food by their means from living parts of plants lasts into summer; at this period the haustoria contain but little starch. In late summer and autumn an absorption of organic compounds from the dead parts of the host takes place. At this period, and later, the haustoria function as places for storage of reserve-materials." Unlike true parasites, this group has green leaves, and so they are capable of carbon assimilation or photosynthesis.

The Cow-wheat is general in Britain, and occurs also in Ireland. In the Highlands it is found at an altitude of 3000 ft.

The habitat is copses, woods, pastures, heaths. The plant occurs on clay and loam in the damp oakwood, and on neutral grass-land. It is found on sandy soil in the dry oakwood, on oak birch heath, and on heaths.

In habit the plant is a hemiparasite. The stem is slender, wiry, with spreading, opposite branches, more or less at right angles. Usually the plant is hairless, or downy. The leaves are linear, lance-shaped or ovate, stalkless, or shortly-stalked, fringed with hairs, entire. The floral leaves are distant, short, toothed below.

The flowers are in distant pairs in the axils, all turned one way, yellow. The calyx is not so long as the corolla, with erect or ascending teeth, lance-

shaped. The tube of the corolla is straight and horizontal, with the lips closed, the lower one projecting. The capsule is ovoid, turned down. The seeds are oblong.

The plant is 6 in. to 1½ ft. in height, usually not more than a foot. It flowers between May and September, and is a herbaceous annual like the other hemiparasites.

Though small, the flowers are conspicuous. The tube is long, and honey can be reached by long-lipped bees, humble bees. Other bees bite through the corolla to get at it. The anthers touch at the margin and form a pollen-box with teeth, below which the bee moves and so releases the pollen. The stigma projects and if insects do not visit the flower the style bends down and the anthers shed pollen on the stigma. Nectar is continuously secreted and sought out by the ants.

The seeds resemble ant chrysalises and may be dispersed by ants.

A general name for the Cow-wheat is Black Corn.

MELAMPYRUM PRATENSE.—*In Fig.* 45 *note the general habit of the plant, the spreading, opposite branches, the linear lance-shaped or ovate leaves, the flowers in pairs in the axils.*

## 56. The Broom Rape Group.

Of the Order Orobanchaceæ there are about a hundred and twenty-five species, which are arranged in some twelve genera. There are about ten British

species, one of which, the Greater Broom Rape, is described.

These plants are natives of North Temperate and Tropical countries, the majority being found in the Old World, in South Europe and East Asia.

They are regarded as having affinity with the Scrophulariaceæ and Cyrtandraceæ or with Gesneriaceæ.

All the Broom Rapes are parasitic plants, being leafless, and practically devoid of chlorophyll. On the roots are suckers by which they are attached to those of other plants such as leguminous plants, *e.g.* Clover, Composites, Bedstraws, Brambles, Thyme, Ivy, etc. According to Vaucher the seeds germinate in contact with the root of the host plant.

In colour the Broom Rapes are brown, purple, cream colour, changing to yellow or blue. The rootstock is tuberous, with or without scales. The stems are simple as a rule, erect, the scales serving as leaves.

The inflorescence is terminal, the flowers being arranged in an erect, loose, or dense raceme or spike, in the axil of a bract, with the other bracts below the calyx. There is a solitary terminal flower. The flowers are hermaphrodite and zygomorphic. The calyx is gamosepalous, hypogynous, inferior, persistent, with two or four (or two to five) sepals, free or united below. The corolla is tubular or bell-shaped, curved, irregular, the limb two-lipped, the upper lip arched, the lower three-fid, and there are hairy folds in the throat. It is overlapping in bud with five lobes.

The stamens are four, in two pairs, didynamous, epipetalous. The anthers are two-celled, the cells parallel, spurred, pointed below, and they open lengthwise by lateral slits or basal pores. The disc, when present, is one-sided. The pistil is inferior, syncarpous, consisting of two carpels (rarely three), and is unilocular. The ovules are numerous, or few, anatropous. The style is single, curved above. The stigma is pin-headed, with two lobes. The capsule is loculicidal, one-celled, two-valved. The seeds are small, few or numerous. The embryo is ovoid, minute. The endosperm is oily.

Toothwort, also a parasite and insectivorous, is included in this group. From *Scrophularia* the Broom Rapes are distinguished in that the ovary is not divided into cells, the placentæ not being joined in the centre, but parietal.

The group includes plants with astringent bitter principles.

### Greater Broom Rape (*Orobanche major*).

Whilst most flowering plants are green and possess chlorophyll, by which they gain their carbohydrates, there are some plants that do not carry out the operations of carbon-assimilation and photosynthesis. These, like fungi, are not green plants. Of these "borrowing" plants there are two types, those that live on other plants, partially or entirely, obtaining their carbohydrates from their hosts, called parasites.

*The Author.* FIG. 46.—GREATER BROOM RAPE (*Orobanche major*). *See page* 158.

*Rev. C. A. Hall.* FIG. 47.—BUTTERWORT (*Pinguicula vulgaris*). *See page* 163.

The other types consist of plants that live in or on decaying organic substances, and derive their nutriment from them. Such are Yellow Bird's Nest, Bird's Nest Orchid, Coral Root, or Saprophytes, the first possessing mycorhiza, and in this way symbiotic.

In the case of parasites, such as the Broom Rapes, the nutriment is derived from the host by the aid of suckers or haustoria, which connect the roots of the parasite with those of the host. These suckers are roots adapted to the special mode of nutrition and parasitism. They are organically united with the tissues of the host, and are equally subject to changes that it may undergo. Some are parasitic upon roots, as here, others on stems, as in the case of Dodder (*ante*).

In the Broom Rape group the embryo does not possess cotyledons, and there is no radicle and no epicotyl. The end representing the shoot remains in the seed. The opposite end takes a spiral course when germinating, and if not meeting with the roots of the host dies, as in the case of Dodder. The developing filament or rootlet adheres to the host, increases in thickness, and dies down above, whilst the lower part sends peg-like structures into the host, living on its sap. A bud is developed, which later becomes a stem, with rootlets, some of which may derive nutriment directly from the soil.

There is some meaning in the name Orobanche, in that it denotes "strangle vetch," the plant living on vetches and withdrawing their substance. The

name Broom Rape is a translation of *Rapum genistæ*, an early specific name for this plant, and meaning much the same as Orobanche.

Where leguminous plants grow the Greater Broom Rape is also to be found. It occurs in all parts of the British Isles, and also in the Channel Islands.

Being parasitical upon the roots of Broom and Furze this species is largely ericetal, found on sandy soil, and on heaths or in dry places.

In colour the plant is pale yellow or brown, turning purplish-brown. The stem is stout, simple, thicker below. The scales are lance-shaped, shorter and broader below.

The flowers form a dense spike, borne on a scape, with bracts (one to each flower) as long as, or longer than, the corolla. There are two sepals, which are one- to three-veined, as long as the corolla, entire or two-fid, and lance-shaped. The corolla is bell-shaped, yellow, and purple, the tube swollen below in front, curved on the back, as long as broad, with an oblique limb. The lower lip is three-fid, the middle lobe longer than the lateral lobes, each with a few small teeth, and wavy ; and the upper lip is hollow, entire, or has two short lobes, with spreading sides. The stigma is yellow. The style is glandular, downy. The anther-stalks are smooth below, and have glandular hairs above, the stamens being inserted at the base of the corolla. The capsule is two-valved. The seeds are small.

The Greater Broom Rape is 1–3 ft. in height,

flowering between May and July, and is a herbaceous perennial.

In its floral mechanism the Greater Broom Rape shows that it is adapted to pollination by insects. There is provision for honey, and this is protected from flies by the hairs on the style and anther-stalks. As in the case of other parasites, however, the flowers are not visited by numerous insects, and must rely largely on self-pollination.

When the capsule has opened, the seeds, being small, are readily blown away by the wind.

Being rather a scarce or local plant the Greater Broom Rape is known by few names, viz.: Orob-strangler, Our Lady of New Chapel's Flower.

OROBANCHE MAJOR.—*Fig. 46 shows two plants attached to the root of a Broom plant. Note the scale-like leaves on the scape, the dense spike of flowers, the bell-shaped, coloured, and long calyx-segments.*

## 57. THE BUTTERWORT GROUP.

In this group, the Order Lentibulariaceæ, are included some of the most interesting plants in the world of plant-life, the so-called Insectivorous or Carnivorous plants whose habits have been so well observed and described by the Darwins. The absence of anything like animal characteristics in the majority of plants, save the sensitiveness of the "sleep" and "sun" plants, etc., has perhaps invested this Order (and those others including Droseraceæ (Sundews),

which embrace similar Insectivorous plants) with a spice of romance which smacks of the animal world.

There are perhaps two hundred and fifty species in this Order included in the genera, *Pinguicula*, *Genlisea*, *Polypomphylox*, *Utricularia*, *Biovularia*, of which the Butterworts and Bladderworts are represented in the British Isles by several species.

Of cosmopolitan range these plants are mainly found in temperate and cold regions. Many of them are found in aquatic or marsh formations.

From the fact that the corolla has a spur like that of the Toadflax the group has been ranged near the Figwort group. The structure of the ovule and capsule, on the other hand, shows that the Butterwort group is nearly related to the Primrose group.

Being adapted to aquatic conditions some of these have the rosette habit, which characterises dry-soil types as a rule, but is developed in some hygrophilous types, as in Compositæ, and even in aquatic types as here. When the habitat is a shallow pool, or moist *Sphagnum*-beds, this habit is the most suited to such conditions. The leaves are mainly radical, in whorls, close together, entire or much divided, without stipules.

The inflorescence is a raceme often one-sided, or a corymb, or a spike. The flower may be solitary, as in the Butterworts. The flowers are hermaphrodite, irregular or zygomorphic, with the parts in fives, with bracts. The flower-stalks are scapes, radical or terminal. The calyx is gamosepalous,

with two to five lobes, sometimes two-lipped, the odd sepal posterior, persistent in fruit, free, inferior. The corolla is gamopetalous, hypogynous, two-lipped, personate, the lower lip spurred, with a short tube, deciduous. There are two stamens opposite the lateral sepals, hypogynous, or epipetalous, the anther-stalks short and arching, with one-celled, unilocular anthers. The ovary is free, one-celled, unilocular. The style is thick and short, or wanting. The stigma is two-lobed, the posterior one functionless. There are many ovules. The fruit is a capsule with many seeds, the placenta large and central, with the ovules buried in it. The capsule opens by two to four valves. The seeds contain no albumen.

The group includes no plant of economic importance. Butterwort was formerly employed as rennet.

### Butterwort (*Pinguicula vulgaris*).

In the Butterwort (hence *Pinguicula*), so called from the greasy fleshy leaves, which were formerly used to curdle milk, we have an example of an insectivorous plant.

Darwin has described an allied species so well that his remarks may with advantage be quoted here. In his 'Insectivorous Plants' he says, "It bears on an average eight rather thick, oblong, light-green leaves, having scarcely any foot-stalk. A full-sized leaf is about 1½ in. in length and ¾ in. in breadth. The young central leaves are deeply concave, and project upwards, the older ones towards the outside

are flat or convex, and lie close to the ground, forming a rosette from 3 to 4 in. in diameter. The margins of the leaves are incurved. Their upper surfaces are thickly covered with two sets of glandular hairs, differing in the size of the glands and in the length of their pedicels. The larger glands have a circular outline as seen from above and are of moderate thickness, they are divided by radiating partitions into sixteen cells, containing light-green homogeneous fluid."

These glands contain a sticky fluid. Darwin drew out a thread of one of these to a length of 18 in. On a single leaf there may be as many as half a million glands. If a small insect alights on a leaf it is immediately caught, as a bird by bird-lime, in the sticky fluid, entangling itself the more it struggles to escape. The leaf margin curls over, and this serves as a further means of imprisonment, and has the effect of pushing the prisoner more into the centre into the thickest array of glands. Darwin counted on four leaves as many as 132 insects. They are digested by the pepsin-like secretion and contribute to the nutriment of the plant.

All parts of the British Isles afford stations for the Butterwort, but it is more common in the West of England and in Scotland and Ireland. It is also found in the Channel Islands.

Bogs form the principal habitat of the Butterwort. It grows also by mountain rills, on wet rocks, in *Sphagnum* swamps. It is found on sandy soil in wet

heaths, on siliceous soils in siliceous grassland, on upland moors in the cotton-grass association and heather-moor association, in arctic-alpine vegetation, and with hydrophilous chomophytes.

The plant is smooth, except at the top of the scape and the calyx, which is glandular. The plant has the rosette habit. The leaves are radical, spreading, ovate, oblong, lying on the ground, blunt, succulent. The leafstalk is broad and short. The leaf-margins are bent inwards. They are light-green with crystalline points, and are wet and clammy in appearance therefrom. The leaves curl back when the plant is uprooted.

The scapes, which are several, are long. The flowers are solitary, terminal, purplish-blue or violet. The lobes of the calyx are ovate, oblong, blunt. The corolla is gaping, with an awl-like, slender, straight or curved spur, not so long as the unequal lobes. The throat is bell-shaped, broad, lateral on the receptacle, with the lower lip longer and broader than the upper. The lobes are oblong, rounded, separate, and entire. There are two anterior stamens, and two lateral ones which are functionless. The capsule is ovoid or nearly rounded, acute, longer than the calyx. There is only one cotyledon.

In height the Butterwort varies from 2–6 in. It is in flower from May to July, and is a herbaceous perennial.

The corolla is personate and spurred as in Toadflax. The lips do not, however, close the flower. Honey

lies at the bottom of the spur. The stigma is not sensitive in this case, as in the Bladderwort, but is pushed back by an insect visitor. The floral mechanism shows the plant is adapted to small bees.

The seeds are blown by the wind out of the capsule, which, when it is ripe, bursts irregularly.

Messrs. Britten and Holland cite the following names for the Common Butterwort: Beanweed, Bog Violet, Butter Plant, Butter-root, Butterwort, Clowns, Earning-grass, Eccle Grass, Rot Grass, Steep Grass, Thickening Grass, Yorkshire Sanicle, Sheep-root, Sheep-rot, Steep-grass, Marsh Violet, White Rot.

Speaking of the greasy feel of the leaves of the Butterwort, Coles remarks that they appear "as if melted butter had been poured upon them." In regard to Earning Grass, Jamieson says "Earning is a north-country word for Cheese rennet." The same writer says it is called Sheep-root, and "said to receive the name because when turned up by the plough the sheep greedily feed on it."

Britten and Holland aptly remark as to the name Sheep-rot, "It is now ascertained that the liver fluke, which always accompanies rot in sheep, exists in one of its stages, as a parasite in the bodies of small water snails (Limnæa), which, in wet weather, creep upon the leaves of marsh plants and are eaten by the sheep with the herbage. It is therefore with some reason that such names as Flowkwort, Sheep-killing, Penny Grass, and Sheep-rot have been given to these marsh plants."

According to Linnæus, milk, warm from the cow,

is poured over a strainer with fresh leaves of Butterwort, until it is turned sour. This imparts to it a compact, tenacious consistency. It acts also in preventing cream being formed. If it curdles the milk curds and whey is formed.

PINGUICULA VULGARIS.—*Growing amongst moss, the specimen depicted in Fig.* 47 *is an excellent example of a rosette plant, with radical leaves, ovate, oblong, with inrolled margin. The solitary flower is borne on a long scape.*

### BLADDERWORT (*Utricularia vulgaris*).

Like the last, Bladderwort is also an insectivorous plant. It is, however of the eel-trap type, possessing, as the English and generic names imply, small bladders, with a trapdoor like that of an eel-basket, which serve to imprison water fleas and other small fry of that type.

Here, again, Darwin well describes their character, and we cannot do better than cite his remarks as to one of these plants. Speaking of the bladders he says, "They are supported on short footstalks. When fully-grown they are one-tenth of an inch (2·54 mm.) in length. They are translucent, of a green colour, and the walls are formed of two layers of cells. The exterior cells are polygonal and rather large, but at many points where the angles meet there are smaller rounded cells."

Inside are processes which serve for absorption of the dead insects, etc. The bladder is straight below,

convex externally, with long processes at the mouth. In form the bladder itself resembles a water flea. The longer processes are branched. The entrance is shut by a flap which closes on a collar. It can be easily opened from outside, and springs back afterwards. The walls of the opening are narrowed at certain points and the flap is semicircular so that it cannot be pushed open from inside. Hence the imprisoned fleas die and are soon absorbed and digested by the plant.

There are few counties in which the Bladderwort does or did not grow, being a native of all parts of the British Isles and of the Channel Islands. In the Highlands it grows at an altitude of 1500 ft., but it is nowhere common and rather local, its former suitable habitats having been destroyed, as in the case of the Sundew and Butterwort, by drainage.

Pools, ditches, water channels, ponds and lakes, canals, highland lochs, are the habitats of the Bladderwort. It is found in the fresh-water aquatic formation in stagnant waters, in waters relatively rich in mineral salts, in the submerged-leaf association, in highland lochs in waters poor in mineral salts, in the free floating-leaf and closed reed-swamp associations.

In habit the Bladderwort is a rosette plant. The aerial stem, a scape, is leafy. The root-like, floating branches bear numerous leaves. The leaves are spreading, broadly ovate, much divided pinnately, with thread-like blunt segments, with bladders on short stalks at their base and here and there between them.

FIG. 48.—BLADDERWORT (*Utricularia vulgaris*).
*Messrs. Flatters and Garnett* (Copyright). *See page* 167.

FIG. 49.—VERVAIN (*Verbena officinalis*) AND FERN (*Asplenium Trichomanes*) IN THE CREVICES.
*Messrs. Flatters and Garnett* (Copyright). *See page* 172.

There are tufts of hairs between the distant teeth on the segments.

The scapes bear two to eight yellow flowers. The ultimate flower-stalks are two to three times longer than the calyx and are bent down after they flower, the bracts being broad and thin. The calyx-lobes are thin and broad. The corolla is spurred, the spur short, conical, curved, the palate two-lobed, convex, broad, not so long as the upper lip, which is broad and short. The lower lip is longer, the margins turned down at right angles. The lateral lobes turn downwards. The anthers cohere. The stigma is irritable.

The height of the scape is 6–18 in. Bladderwort flowers in June and July and is a herbaceous perennial.

The flowers are like those of the Snap-dragon. The two lips close the flower. The upper lip is simple, the lower consists of three parts, the spur containing honey, the arched part which touches the upper lip, and the lateral lobes. On the lower lip the insect visitors (flies) alight and press the lip down, gaining access to the spur. The pistil and stamens lie under the upper lip. The stigma projects and an insect touches it first. The anthers open downwards and are touched also by an insect. The receptive portion of the stigma is above, touching the upper lip. It turns down on the opening of the flower and in this stage a fly may touch it. Being irritable it rises after being touched, and when the fly withdraws itself the pollen of the same flower is not

transferred by its means to its own stigma, but to that of another plant on the next visit. The stigma has a row of hairs on the margin which serve to brush the pollen of a plant visited previously from an insect visitor's head.

The seeds of the Bladderwort, which are dispersed when the capsule bursts irregularly, are borne away by the current or fall to the bottom.

Bladderwort is called Bladder-snout, Bladderwort, and Hooded Water Milfoil.

UTRICULARIA VULGARIS.—*Fig.* 48 *shows the branches bearing numerous much-divided leaves, with bladders on short stalks at the base of the filamentary segments.*

### 58. THE VERVAIN GROUP.

Although a large group the Order Verbenaceæ is represented in the British Isles by only one species, the Vervain. There are about seven hundred and fifty species and sixty-seven genera. They are mainly sub-tropical or tropical in range, found in America, Asia, Africa. In this group are included garden Verbenas, *Lantana*, *Vitex*. Some are lianes as the last two. In some cases the plants are adapted to dry conditions, and are provided with thorns.

These plants are herbs, shrubs, or trees. The leaves are usually opposite, occasionally alternate, or in whorls. There are no stipules. The leaves are entire or lobed.

The inflorescence is a raceme or a cyme. If a raceme it is a head or spike, with an involucre of

coloured bracts. The cymose inflorescence may be a cincinnus, or form a head. The flowers are hermaphrodite, irregular, zygomorphic, with the parts in fives, with bracts. The calyx is inferior, hypogynous, tubular, five-lobed (or four to eight), overlapping in bud. The corolla is bell-shaped, with a narrow tube, hypogynous, two-lipped, five-lobed, overlapping in bud. The stamens are four (or five or two) didynamous, epipetalous, unequal. Two are longer than the other two. They alternate with the lobes of the corolla. The anthers are two-celled and open inwards. The ovary is superior, two- or four-celled, four-lobed, entire. The style is sunk between the lobes of the ovary, terminal, simple. The stigma is two-cleft, or simple. It is at first bilocular, then divided into four or more loculi by a false septum. The carpels possess two ovules, one in each loculus after the septa are formed. The placentæ are axile. The solitary or two collateral ovules are anatropous or orthotropous. The fruit is a berry two- or four-celled, a drupe with two to four stones, one- to two-celled, or a capsule or schizocarp or nutlet (usually four in number). The seeds possess no albumen. The cotyledons are leaf-like.

In the characters of the ovary the group differs from the Deadnettle group to which, however, it is most nearly related. There is some affinity also to the Viper's Bugloss or Comfrey groups.

The flowers are adapted to bees. The stigma and

anthers ripen simultaneously. Honey, protected above by hairs, is secreted at the base of the ovary.

In the Vervain group are many plants that are fragrant, as Verbena or the Lemon plant, or aromatic, some being considered medicinal. The Vervain was considered to be a holy plant and was used in witchcraft. Teak, *Tectona*, is a valuable timber tree, being very hard and attaining a height of 200 ft. It contains particles of silica.

### Vervain (*Verbena officinalis*).

Held in great esteem formerly from some exaggerated notion as to its homœopathic properties (hence *officinalis*), Vervain, no doubt, like other "herbs," owes its existence in most of its stations to-day to this circumstance.

The word Verbenæ denoted sacred boughs or branches used in religious ceremonials, and is possibly a contraction of hiera and botane, sacred plant. Pliny in writing of the names Sagmen and Verbena, says, "These two names no doubt originally signified the same thing—a green turf torn up from the citadel, with the earth attached to it and hence, when envoys were despatched to the enemy for the purpose of clarigation or, in other words, with the object of clearly demanding restitution of property that had been carried off, one of these officers was always known as the verbenarius."

Generally distributed in England and found in

Ireland, though it is local there, Vervain is not known in Scotland. It occurs in the Channel Islands. It appears to be most common in the south of England.

As a rule the habitat of Vervain is dry waste places, near villages or houses. It also grows by the roadside, and I have seen it in Norfolk on walls.

Erect in habit, the plant is smooth or downy. The stem is wiry, rigid, with long, spreading branches in the upper part solitary, four-angled, from a woody rootstock. The lower leaves are inversely ovate, oblong, pinnatifid, stalked, sometimes with coarse teeth, with blunt or acute lobes. The leaves are opposite. The upper leaves are few, stalkless, lance-shaped, narrower.

Arranged in a long, dense, slender spike, which lengthens in fruit, the flowers are pale purple and small, distant. As the panicled spike lengthens the lower flowers become more distant. The bracts are ovate, acute, about half as long as the calyx, which in turn is half as long as the tube of the corolla. There are four stamens. The nutlets are blunt, granulate.

In height Vervain is 1–2 ft., and it flowers late in August and September. It is a herbaceous perennial.

Honey is secreted at the base of the ovary. A ring of hairs serves to protect it, as does the form of the corolla. The lower part of the tube, which is 3–4 mm. long, is turned upwards and the upper outwards. This serves also to protect the stigma and

anthers. The anthers and stigma ripen together. The flowers are adapted to bees, which may cross-pollinate them.

The nutlets fall, when ripe, near the plant.

Amongst the names by which this plant is known are Ashthroat, Berbine, Columbine, Pigeon's Grass, Holy Herb, Juno's Tears, Mercury's Moist Blood, Simpler's Joy.

As some of the above names indicate great veneration was accorded to this plant in the past. When the gods held a feast it was used to cleanse the table. Vervain was also employed to purify the house. Henslow, in his 'Uses of Plants,' cites an old author thus, in reference to its reputed value as a vulnerary: "If a man lie sick, to know whether he shall live or die, take Vervain in thy right hand, and take his right hand in thine, and let the herb be between so that he does not know it. Ask him how he fareth, and how he hopeth of himself. If he say he shall live and fare well, for certain then he shall live and fare well. But if he say he hopeth of no life, know well for certain that he shall die of that evil." This is a fair sample of the *Materia medica* of the Middle Ages. By doctrine of signatures it was also used as an eye salve, from the eye-like corolla.

VERBENA OFFICINALIS.—*Note in Fig.* 49 *the wiry, spreading branches, the pinnatifid lower leaves, the narrow, lance-shaped upper leaves, the dense, slender spike, with small distant flowers.*

## 59. The Deadnettle Group (Summary).

(*Introductory Volume, p. 167.*)

As representatives of the Order Labiates three common plants were described in the Introductory Volume—Self-heal, Woundwort, and the White Deadnettle. Some 2800 species included in 150 genera are known. They are cosmopolitan in distribution. A large proportion are natives of the Mediterranean region. They are not so widely distributed in Arctic and Alpine regions, being mainly confined to the Temperate and Tropical zones.

The Labiates are distinguished from other groups of the Gamopetalæ, except the Viper's Bugloss group, by the four-lobed ovary and four nutlets, like seeds, enclosed in the calyx, and they are distinct from the latter in having opposite leaves, in not possessing five stamens (but four), and in the distinctly zygomorphic flowers.

Nearly all the Labiates are terrestrial, but a few are hygrophilous, as the Mints, and marsh plants. Rosemary is a xerophyte, with leaves reduced and infolded. In habit these plants are herbs or shrubs, or undershrubs. The stems and branches are four-angled. The leaves are in opposite pairs, decussate, or in whorls, simple as a rule, with no stipules.

The flowers are racemose or in dichasial cymes, solitary, or in the axils of upper leaves, opposite, centrifugal, crowded, falsely whorled, in a verticil-

laster or thyrsus. They are irregular, hermaphrodite, or gynodiœcious, with two bracts to each whorl, and a pair below each inflorescence. They are hypogynous, with the parts usually in fives. The calyx is hypogynous, gamosepalous, with five sepals, or two- or three-lobed, tubular, bell-shaped, funnel-shaped, occasionally two-lipped, ribbed, inferior, persistent in fruit. The corolla is gamopetalous, two-lipped, the separate petals not well marked, but with a tube and a four to five irregularly-lobed limb, making two lips, the upper outermost. It is deciduous, overlapping in bud. The stamens are four, didynamous, or equal, epipetalous, inserted on the tube, with a fifth (rarely present), and two lateral, imperfect. There may be only two stamens. The anthers are polymorphous, opening inwards. The pistil is syncarpous, superior. The ovary is situated on an annular honey-disc of two carpels. It is very soon constricted. It is four-lobed, with one erect ovule in each lobe, and a single central style, with a simple or two-lobed stigma. The style is placed between the two lobes of the two carpels united below. The fruit consists of four nutlets or achenes, one-seeded. Rarely it is a drupe. The seeds have no endosperm, and are erect or nearly so. The cotyledons are fleshy. The embryo is usually straight.

The flowers are usually proterandrous. Honey is secreted at the base of the tube. The lower lip serves as an alighting-place for insects, and the

stigma projects beyond the unequal anthers, and pollen is deposited by the anthers on the insect's back. The flowers are mainly adapted to bees. In Salvia there is a lever mechanism. Some plants are gynodiœcious. In Woodsage the floral members move in relation to pollination of the flower.

The fruits are dispersed by the bladdery calyx in some cases, in others hooks serve to disperse them. A few plants have hygroscopic stalks.

The group is important from the large number of plants, such as Sage, Thyme, Balm, etc., that yield volatile oils. Perfumes are derived from them, *e.g.* Lavender.

Five tribes are recognised by Bentham and Hooker, Satureineæ with flat corolla-lobes, or with bent-back margins, two to four distant stamens, spreading or meeting under the upper lip, contiguous or confluent anthers, and free, smooth nutlets, including *Mentha*, *Lycopus*, *Origanum*, *Thymus*, *Calamintha*, *Melissa*. The second tribe, Monardeæ, includes those plants, such as *Salvia* with two stamens, erect or ascending, one-celled anthers (or with two distant cells), free, smooth nutlets. In the Nepeteæ there are four stamens, two upper longer, ascending or spreading, two anther-cells parallel, smooth or tubercled nutlets, as *Nepeta*. In the Stachydeæ there are four stamens, parallel, the two upper shorter, ascending under the concave upper lip, or included in the tube. The nutlets are free, smooth or tubercled. This includes *Brunella*, *Scutellaria*, *Melittis*, *Marrubium*, *Stachys*,

*Galeopsis*, *Leonurus*, *Lamium*, *Ballota*. In the Ajugoideæ there are four stamens, parallel, ascending, exserted, two upper shorter. The nutlets are connate, the base oblique, reticulate and rugose, and this tribe includes *Teucrium* and *Ajuga*. A type of each is described here or in the Introductory Volume, *Mentha hirsuta*, *Salvia Verbenaca*, *Nepeta hederacea*, and *Ajuga Chamæpitys* being described hereafter.

### Hairy Mint (*Mentha hirsuta*).

Called also Water Mint and Horse Mint (and *M. aquatica*), Hairy Mint is characterised by being more clothed with rigid hairs than other species, and it is a moisture-loving plant, fond of water (hence *aquatica*).

As a universally common plant, Horse Mint (so called because of its coarseness) is found in all parts of the British Isles up to the Orkneys. It grows at an altitude of 1500 ft. in Yorkshire. It does not appear to be so common, however, in Scotland. It is found in the Channel Islands.

As denoted by the names Water Mint (and *aquatica*) it is a moisture-loving plant. The habitat is wet ditches, marshes, the edges of streams and rivers, or wet places generally. It is found on clays and loams in neutral grassland, where there is a rush association, as well as on limestone in ashwoods, where there is a marshy tract.

Ascending or prostrate in habit, the plant is much-branched. As the names given above imply it is softly-hairy. The stems are four-angled and tall.

*W. E. Mayes.* FIG. 50.—HAIRY MINT (*Mentha hirsuta*). *See page* 178.

*The Author.* FIG. 51.—CLARY (*Salvia Verbenaca*). *See page* 180.

The leaves are ovate to oblong, crowded or heart-shaped below, stalked, coarsely-toothed, hairy both sides, the upper ones bract-like.

The flowers are in a dense, oblong, or round, terminal head, interrupted below, or in the axils. They are lilac. The calyx is glandular, tubular, the teeth pointed, triangular, half as long as the tube. The bracts are not as long as the flower-heads. The flower-stalks and flowers are hairy. The throat of the calyx is naked. The fruit is a nutlet.

This is a tall species, from 1–4 ft. high. It flowers in July and August. The Horse Mint is a herbaceous perennial with aerial leafy stolons.

As the whole plant is aromatic and the light-coloured lilac flowers are conspicuous the flowers are readily detected by insects and much visited. The flowers are hermaphrodite. The anthers ripen before the stigma. Some of the flowers are smaller and female, and these are more numerous. The corolla is two-lipped, and adapted to insect visits.

The fruit falls near the plant, often in the water, when the plant grows in the reed-swamp.

Bishop's Weed, Bishop's Wort, Fish Mint, Baulme Mint, are names cited by Britten and Holland.

Some of the Mints are used in the manufacture of the Peppermint, as *M. piperita*, which may be derived from this species.

MENTHA HIRSUTA.—*Note in the illustration (Fig. 50) the long-stalked, opposite, ovate leaves, the axillary and terminal heads of flowers.*

### English Clary (*Salvia Verbenacà*).

Like Vervain, Clary is no doubt largely dependent, in so far as its present universal distribution is concerned, upon its former use as a herb, it being called also Wild Sage.

In England it is generally distributed, but in Scotland it is found more abundantly south of the Forth, and chiefly on the eastern side. It is found also in Ireland and the Channel Islands.

Dry pastures appear to be the most native habitat for Clary. Usually it is found in waste places, by the roadside, on village greens, in churchyards, on gravelly banks. With it the writer has found Corn Parsley at the foot of a churchyard wall, with Knotted Hedge Parsley, the two last being frequently associated in more natural habitats.

Having more or less the rosette habit and radical leaves lying on the ground Clary is an erect plant. It is usually hairy or smooth below, glandular hairy above, the stem leafy, with few branches. The radical leaves are numerous, stalked, ovate, oblong, heart-shaped below, blunt, with coarse, angular, wavy teeth, or they may be scalloped, wrinkled. The upper leaves are few, stalkless, clasping, oblong, heart-shaped or triangular to ovate, broader and not so long.

The flowers are bluish-violet, in a terminal spike, with bracts, and six flowers in a whorl. The bracts

are fringed, ovate to heart-shaped, acute. The calyx is bell-shaped, the upper lip broad, having the edges bent back, and with small spiny, convergent teeth, the lower ones awl-like. The corolla is small, and has a tube as long as the calyx. The upper lip is short and flattened at the side, hollow, straight, except at the tip, smooth within. The connective is long and slender, enlarged, with a wing to the antherstalk. There are two stamens, the others or third and fourth stamens being functionless. In water the nutlets become mucilaginous.

Two to four feet is the usual height of Clary. It flowers from June to August, and is a herbaceous perennial.

Though there are four stamens, two are functionless, and those that produce pollen are united by a connective. In the common Sage, where the arrangement for pollination is similar, the anthers ripen first and then shrivel. The pistil lengthens and curves down so that an insect visitor may then touch it with its back on a part on which pollen in a younger flower would also come in contact with it, so that cross-pollination is ensured. The lower lip serves here as in other Labiates as an alighting place for insects, and the upper lip is curved and protects the stigma, anthers, and the honey at the base of the ovary. The anthers are connected in Clary, whereas in the Sage, they move on a pivot, and the bee in pushing one end in, is hit by the longer ones on the back. The connective is not moved in this case, but the insect

pushes back the hood, which is movable, the narrow part below serving as a hinge. The pistil is also longer at length and projects. There are in some cases cleistogamic flowers.

The fruit is an achene or nutlet, protected by the calyx, and falls, when ripe, near the plant.

*Salvia* is from salvo, I heal, the plant being used medicinally, in Pliny's day. *Verbenaca,* an earlier generic name, means resembling Verbena.

Clary is called Christ's Eye, Wild Clary, Clear-eye (hence Clary), Wild Clear-eye, Eyeseeds, Oculus Christi.

In reference to the name Eyeseeds, a writer describes it as "A plant whose seeds, if blown into the eye, are said to remove bits of dust, cinders, or insects, that may be lodged there."

Clary is from *clarus,* clear. The fruit was put on the eye to clear it.

SALVIA VERBENACA.—*In Fig.* 51 *are shown the oblong, wavy teeth, much wrinkled, and the flowers, borne on terminal spikes, in distant whorls.*

### GROUND IVY (*Nepeta hederacea*).

Considerable confusion exists amongst the uninitiated as to the identity of Ground Ivy. The real Ivy is dimorphic or heterophyllous and there is a prostrate form which is also known as Ground Ivy, which does not climb up trees or other supports, but trails over the hedgebank and does not flower, the

*B. Hanley.* Fig. 52.—Ground Ivy (*Nepeta hederacea*). *See page* 182.

*W. E. Mayes.* Fig. 53.—Ground Pine (*Ajuga Chamæpitys*). *See page* 186.

leaves also being lobed, whereas the other or climbing form has entire leaves on the flowering stems. The plant under description is, of course, a member of a different order, with a labiate corolla. The trailing habit has gained for it the name Ground Ivy, but the resemblance to the former ends there, and the leaves are scalloped, not lobed.

The second Latin name well describes the habit if it refers to the trailing character. An earlier name *Glechoma* is from the Greek Glechoma, Pennyroyal. *Nepeta* is a pre-Linnean name bestowed by Pliny, the etymology of which is uncertain, but it may possibly be derived from Nepi, an Italian town, or from Nepa, a scorpion, as it was regarded as a cure for that animal's sting.

Frequent in all parts of the British Isles, Ground Ivy ascends to nearly 1400 ft. in Derbyshire, and is found in Ireland and the Channel Islands.

A common plant by the wayside in hedges on a sloping bank, Ground Ivy grows also in woods, copses, and in waste places. It grows on clay and loam in damp oakwoods, and in neutral grassland, on limestone in the drier parts of ashwoods, and on limestone scrub, as well as on chalk in chalk grassland. It is very abundant on the rubble of the Lincolnshire Oolite.

Trailing in habit, the plant is prostrate at first, then ascending. The stems form chain-like masses, rooting below, and are slender, and branched. The plant is downy as a rule. The leaves are rounded,

kidney-shaped or heart-shaped, entire, with a scalloped margin. The lower leaves have longer stalks.

The flowers are bluish-purple, stalked, in axillary whorls of three to six flowers, arranged all one side. The flowering stems are ascending. There are awl-like bracts which equal the short ultimate flower-stalks. The flowers are of two kinds, dimorphic, the larger hermaphrodite, the smaller ones female. But the latter may be the only ones found on the plant, and this form constitutes the variety *parviflora*. The calyx-teeth are ovate, long and narrow-pointed, awned. The tube of the corolla varies in length, being usually twice as long as the calyx, but often three or four times in the complete flowers. The nutlets are oblong with impressed dots.

Ground Ivy is from 6–18 in. in height. It flowers early in March, continuing up till May or later. It is a herbaceous perennial, propagating itself freely by offsets.

In the floral mechanism Ground Ivy, like Catmint, differs from other Labiates in the arrangement of the stamens. In the latter the outer stamens project beyond the inner, whereas in *Nepeta* the inner are the longer. The flowers are conspicuous, and bloom early so that they are much visited. They are very numerous, too, on the same plant. As noted above they are dimorphic. The smaller form must of necessity, if seed be set, be cross-pollinated, as stamens are absent. The tube of the corolla is lined with hairs, which protect the honey. The large-

flowered hermaphrodite form has a tube 13–16 mm. long, whereas in the female flowers it is only 6–8 mm. long. The distribution of the large- and small-flowered types, according to Willis, varies in the same year. The plant is gynodiœcious.

The nutlets fall, when ripe, near the plant.

As a common plant Ground Ivy has many vernacular names, which, according to Britten and Holland are, Alehoof, Allhoove, Alliff, Bird's Eye, Blue Runner, Cat's Foot, Deceivers, Devil's Candlesticks, Fat Hen, Foalfoot, Folesfoth, Gell, Gill, Gill-ale, Gill-go-by-ground, Groundavey, Ground Ivy, Hayhofe, Haymaiden, Hay-maids, Hedge-maids, Heihow, Hen and Chickens, Heyhove, Hove, Jenny-run-ith-ground, Jill, Lion's Mouth, Lizzy-run-the-hedge, Maiden-hair, Mould, Nip, Robin-run-the-Hedge, Rob-run-up-dyke, Run-away-Jack, Runni-dyke, Tudnoore, Tunhoof.

The name Devil's Candlesticks is current in Warwickshire, and in Germany Thunder-Vine. In Sussex it is called Aller. Carried about with Broom, Straw, Agrimony, Maiden-hair, and Rue, the Ground Ivy was supposed, in the Tyrol, to reveal witches, according to Conway. The name Alehoof is considered to have some connection with the former practice of wearing or dressing objects with garlands.

In classic names the plant is commemorated as Earth-crown. The word hoof may, indeed, be from the A. S. hufe, a crown. In this connection a chaplet was placed on the ale-stake at inns, and Chaucer writes:

> "A gerlond hadde he sette upon his heed,
> As gret as it were for an ale-stake."

Ground Ivy is bitter and aromatic. It was formerly used in beer to flavour it, and has also been dried and used to make tea. The name Gill is from the French guiller, to ferment. With the Groundsel and Plantain the plant was used for ulcers of the eye, and to remove the white specks in horses' eyes.

Nepeta hederacea.—*In Fig. 52 note the social habit, the downy stem, rounded, kidney-shaped leaves, and scalloped margin, the whorls of leaves.*

### Ground Pine or Yellow Bugle (*Ajuga Chamæpitys*).

Pliny states that his name *Ajuga*, adopted by Linnæus, is a correction from ambiga, a Latin name for a plant used in medicine (from abigo, expel). The second Latin name means Ground Pine, in allusion to the needle-like leaves and general appearance like a branch of the Pine (*Pinus*).

Rare in England, the Ground Pine, which is considered by Watson to be a colonist, is found only in a few counties in the south-east and east of England, such as Hants, Kent, Surrey, Essex, Herts, Bedford, and Cambridge, or in the region of the chalk escarpment.

Chalky fields, dry places, cultivated stony fields, waste places are the habitat of this plant. Sometimes, as in the case of other chalk plants, it grows

on sand, there being a sandy, ferruginous layer on the top of the chalk as a general rule. On the chalk it is found on chalk pasture.

In habit the Ground Pine is prostrate, then ascending. The plant is much branched, hairy, with long, scattered hairs, the stem being of a reddish-purple tinge, low, and spreading. The leaves are crowded, the radical leaves soon withering, stalked, ovate to lance-shaped, entire or toothed. The stem-leaves are divided into threes, with narrow linear, entire segments, which (the laterals) may branch again, and are spreading, some flat, clammy.

The flowers are yellow, with dark spots, solitary, in the axils, with leaf-like bracts longer than the flowers, in numerous whorls, containing two flowers each. The calyx bears stiff hairs, and has narrowly triangular teeth. The nutlets are large, oblong, with deep pits.

Three to six inches is the height of this plant, which flowers between May and August, and is a herbaceous perennial.

Honey is secreted at the base of the ovary. A ring of hairs protects it above. Though the corolla has a rather short upper lip the stigma and anthers are protected by the bract which subtends the flower above. The stigmas mature in advance of the anthers, and spread apart. The anthers are first touched by an insect visitor, as the stigma is protected from contact in a young flower by the stout stamens. Cross-pollination is ensured. The inferior

stamens separate, and then the stigma which projects comes in contact with the bee-visitor.

The nutlets are dispersed near the plant when ripe.

Field Cypress, Forget-me-not, Gout Ivy, Ground Ivy, Ground Pine, Herb Eve, and Herb Ive are names the plant has received.

AJUGA CHAMÆPITYS.—*In Fig.* 53 *the whole plant is shown, to give an idea of the habit, which is much like that of the clusters of leaves on the branches of a pine. The axillary flowers with the bracts exceeding them are readily discernible.*

## CHAPTER II

### APETALÆ (MONOCHLAMYDEÆ AND ACHLAMYDEÆ) (SUMMARY).

(*Introductory Volume, p. 175.*)

ANOTHER name for this division, recognised by Bentham and Hooker, is Incompletæ. This implies that the floral mechanism lacks some members, not being as in Polypetalæ and Gamopetalæ complete, with a corolla and a calyx.

The name Apetalæ denotes that the corolla is absent. The calyx also is absent in many cases. The absence of either is, however, not a natural distinction, and in Engler's new system (*vide* Appendix) this defect of the present system is largely remedied. Moreover there are many types of Polypetalæ that exhibit a similar characteristic, as in some Ranunculaceæ, Cruciferæ, Violaceæ, Caryophyllaceæ, Rosaceæ, Saxifragaceæ, Haloragaceæ, Lythraceæ, and Onagraceæ. Amongst Monopetalæ or Gamopetalæ also, where, as a rule, the flowers are dichlamydeous, the corolla may be absent in some of the Oleaceæ and Primulaceæ. Moreover, in Illecebraceæ the petals are present, though small.

The names Monochlamydeæ and Achlamydeæ

refer to the character of the perianth, or the number of whorls. In the former there is but one, the calyx generally speaking; in the latter there is no perianth as a rule. But in the former group Euphorbia is included, and in this there is no perianth.

The Monochlamydeæ include orders in which the flowers are not in catkins. The perianth is single and inferior. Here are included:

| | |
|---|---|
| (1) Illecebraceæ. | (5) Elæagnaceæ. |
| (2) Chenopodiaceæ. | (6) Euphorbiaceæ. |
| (3) Polygonaceæ. | (7) Urticaceæ. |
| (4) Thymelæaceæ. | (8) Ceratophyllaceæ. |

In Nos. 1, 3, 4 the flowers are bisexual. In 2, 5 and 7 they may be unisexual or bisexual. In 6 and 8 they are unisexual.

The other section embraces plants with flowers not in catkins, and with a single, superior perianth, *e. g.* Loranthaceæ, Santalaceæ, and Aristolochiaceæ.

In the case of the Achlamydeæ both calyx and corolla are wanting except in Cupuliferæ. The flowers are also unisexual, the males in catkins, the females in spikes or catkins. There may be a perianth or it may be wanting. In the Myricaceæ the flowers are of both sexes and there is no perianth. The plants are monodiœcious in the Cupuliferæ and there are no sepals, or five or more. In the Salicaceæ the plant is diœcious and both of the sexes are in catkins.

None of the members of this group possess albumen in the seeds. In Myricaceæ and Salicaceæ the ovary is one-celled, in Cupuliferæ two- to three-celled.

This section includes chiefly trees. The majority of them flower before they put forth their leaves, and possess numerous stamens and a large stigma, being wind-pollinated. Wind plays also a great part in the dispersal of the fruits.

### 60. The Strapwort Group.

Amongst British plants of the Order Illecebraceæ are included the Strapwort, Rupture-worts, *Illecebrum*, and the Knawels. Babington places *Illecebrum* in the Order Paronychiaceæ in the Gamopetalæ, but does not include *Scleranthus*, which he places in the Caryophyllaceæ. They are placed in the latter group, in fact, by Pax, in a family Paronychieæ, in the sub-Order Alsinoideæ including *Paronychia*, and *Scleranthus* is placed in a family by itself.

Diagrammatically Pax gives the relationship of this order to others thus:

$$\begin{array}{ccc} & \text{Caryophyllaceæ.} & \\ \left.\begin{array}{r}\text{Amaranthaceæ.}\\ \text{Chenopodiaceæ.}\end{array}\right\} & \begin{array}{c}\uparrow\\ \text{Phytolaccaceæ.}\\ \downarrow\end{array} & \left\{\begin{array}{l}\text{Aizoaceæ.}\\ \text{Nyctaginaceæ.}\end{array}\right. \\ & \text{Portulaceæ.} & \end{array}$$

The affinities are thus more or less between Amaranthaceæ and Caryophyllaceæ. The petals are reduced to some filaments except in *Corrigiola*, where there are five as long as the sepals. They may be considered as imperfect stamens. There are about sixty species, included in seventeen genera. Confined

to warm and dry regions, being adapted to drought, the members of this group have a wide range.

They are herbaceous plants of low stature, spreading or prostrate. The rootstock may be woody and perennial with annual flowering stems. The leaves are opposite or alternate, entire, toothed. There are no stipules in Knawel. The other types possess membranous stipules.

The flowers are small, hermaphrodite, in cymes, terminal or axillary, rarely solitary. The calyx is five-lobed (four or three), and the sepals are distinct or united below, persistent, closing over the fruit. The petals are small or wanting, of the same number, inserted at the base of the calyx. The stamens are hypogynous or perigynous, with short anther-stalks, which are distinct or united at the base, as many as the sepals or fewer, placed between the petals. The anthers are small. If a disc is present it is annular. The ovary is free, ovoid, one-celled. The style, if present, is two- to three-fid. The stigmas are decurrent. The ovule is single, erect, or pendulous. The fruit is a utricle enclosed in the perianth, and one-seeded. The seeds are round, kidney-shaped, with a straight, curved, or annular embryo.

The group includes no plants of economic importance.

### Knawel (*Scleranthus annuus*).

Knawel is derived from the German Knawel and is a mere book-name. The name *Scleranthus* is from

*The Author.* Fig. 54.—Knawel (*Scleranthus annuus*). *See page* 192.

*W. E. Mayes.* Fig. 55.—Red Goosefoot (*Chenopodium rubrum*). *See page* 196.

the Greek scler, hard, and anthos, flower, from the hard character of the perianth.

This plant is found in all parts of the British Isles, as far north as Caithness, but is commoner in the south, and ascends to 1000 ft. in the Highlands, being also native in Ireland and the Channel Islands.

Cultivated ground, cornfields on a gravelly soil, fields, waste places, form the habitat of this plant. It grows on sandy soil also in grass heath.

The habit is tufted. The plant is much branched, erect or spreading, the stems green, repeatedly forked, slender, slightly downy. The leaves are narrow, linear, awl-like, fringed with hairs at the base, bent back, and are adapted to dry conditions.

The flowers are green, in terminal forked cymes, or corymbose, tufted, solitary in the lower axils. The lobes of the calyx are nearly erect in fruit, acute, stiff, narrow, as long as the tube, with a narrow membranous border, the tube ten-grooved, and enlarged after flowering. There are ten stamens, which are not so long as the styles.

Knawel is 2–8 in. in height. It flowers from May or June to September, and is a herbaceous annual.

There is a biennial form which has a shorter stem and is found in dry places.

Like some other apetalous flowers Knawel is dependent upon pollination by the wind. The styles exceed the stamens in length. The stamens are numerous.

The fruit is a utricle which does not open, and is one-seeded. It falls, when ripe, close to the plant.

The names by which this plant is known are German Knotgrass, Knawel, Knotgrass, Parsley Pert or Piert. The latter name is a common one for *Alchemilla arvensis*, a plant which is frequently found in association with it, but with which it cannot be readily confused.

SCLERANTHUS ANNUUS.—*In the illustration* (*Fig.* 54) *the tufted habit is shown, also the forked stems, the awl-like, linear, bent-back leaves, and the tufted flowers, in the axils, or terminal.*

## 61. THE GOOSEFOOT GROUP.

A common characteristic of the Order Chenopodiaceæ is the shape of the leaves, which resemble that of a goose's foot, except in the case of Good King Henry in which they are more spear-shaped.

There are about five hundred species in this Order, included in some seventy-five genera. Being largely halophilous the distribution, as shown by Bunge, is peculiar, and embraces Australia, the Pampas, Prairies, Mediterranean coasts, Karoo, Red Sea borders, S.W. Caspian coasts, Central Asia, from the Caspian to the Himalayan region, the salt steppes of Eastern Asia.

Being halophilous they exhibit adaptations to resist drought, as the character of the soil in the salt regions in which they grow retards absorption by the roots, owing to the excess of mineral salts in the soil water, causing physiological drought. Here, also, physical drought in turn plays as great a part.

Herbs or shrubs, or undershrubs, this group includes many succulent types, as Samphire. The leaves (and stems) are often fleshy, the former alternate, or opposite, frequently hairy. There are no stipules. In Samphire the leaves are wanting, and the plant has the cactus habit with jointed stems and branches.

Primarily the inflorescence is racemose, with cymes in the ultimate branching, with axillary and terminal clusters. The flowers are frequently unisexual, or hermaphrodite, regular, small, sometimes dimorphic. There are one to three bracts or none. The perianth is single, simple, or absent, sepaloid, or calyx-like, inferior, of three to five segments, free or united below, persistent in fruit, overlapping in bud. There is no corolla. The stamens equal the perianth-segments in number (usually five), and are opposite the latter, hypogynous or inserted on the disc, or perigynous. The anthers are two-celled, inbent in bud. The ovary is one-celled, free, superior, ovoid, round or flattened. In the Beet it is half inferior. There are usually two stigmas (or two to four). The styles are free or united at the base. There is a single basal or lateral ovule. The fruit is a utricle, membranous, or a round nut or achene, which is enclosed in the succulent, fleshy pericarp, with a persistent, sometimes enlarged, calyx. The seeds are round or flattened, and horizontal or vertical. The embryo possesses endosperm.

Pollination is usually effected by the wind, but self-pollination appears to be general. The Goose-

foots are frequently covered with small creeping insects which may affect cross-pollination.

Most of the Goosefoots are potherbs, as Mercury, Spinach. The group also includes Beet for sugar, Samphire, much used as a pickle. Mangel Wurzel is allied to the Beet. Soda or barilla is produced from Saltwort.

The relationship of the group is with the Amaranth group, but it differs in the presence of bracts, and the scarious, membranous, or coloured perianth.

### RED GOOSEFOOT (*Chenopodium rubrum*).

Few of the Goosefoots are more handsome than the Red Goosefoot, with its vinous tinged foliage. Moreover, it is a tall, stately plant and a group of individuals makes a brave array of colour.

Found in England generally, it occurs in Scotland more abundantly in the southern counties. It is found also in Ireland and in the Channel Islands.

Waste places form the principal habitat of this plant, which appears to be more common near the coast. It occurs also by the roadside, and in cultivated fields, in ditches, in salt-marshes.

Red Goosefoot is more succulent than many of the other Goosefoots. It is quite smooth and often shining. The habit is usually erect, sometimes ascending. The stem bears leaves throughout. The plant is red in colour, more especially in maritime habitats, and possibly the abundance of red colouring matter or anthocyan may serve to maintain a normal

temperature by transforming the light rays into heat in stations where the atmospheric conditions are subject to fluctuation, or where radiation is rapid and the temperature liable to suddenly fall. The leaves are triangular, rhombic to ovate, entire, with irregular coarse teeth, wavy, blunt or acute, three-nerved below.

Borne in erect, short, terminal and axillary, leafy panicled spikes, which are dense and compound, the flowers are incomplete. There are two or three perianth-segments. They are not keeled, and are narrow, with a membranous border, covering the utricle. The stigma is short. The pericarp is loose. The seeds are small, smooth, brown, shining, with a trace of a keel, and vertical.

Dwarf plants may be but 2 in. in height, but the Red Goosefoot is sometimes nearly 4 ft. high, flowering from August to October. It is a herbaceous annual.

The flowers are as a rule wind-pollinated. They are inconspicuous, but being reddish may attract small insects, and creeping ones may carry the pollen about. The stigma is ripe in advance of the anthers. The flowers are hermaphrodite, and being numerous in an erect spike wind may readily cause pollination, as there is no corolla and the perianth-segments are few and short.

The utricle, when ripe, falls off and is dispersed near the plant.

Fat Hen, Goose-foot, Pig-weed, French Spinach are the names applied to Red Goosefoot.

Chenopodium rubrum.—*In Fig.* 55 *note the triangular leaves with irregular teeth, and the long, panicled spike, with terminal and axillary flowers.*

### Orache (*Atriplex hastata*).

Whilst the Goosefoots as a whole are light green or yellow in colour the Oraches are much darker green. The perianth in this case also is enlarged in fruit. The first Latin name is derived from two Greek words which imply not nutritious, whereas the Goosefoots are valuable as salads or potherbs.

Considered in the aggregate sense this Orache is found in all parts of the British Isles. In the North of England it ascends to nearly 1500 ft. Formerly this and other species were included in a comprehensive species—*A. patula*—but are now kept distinct, differing as regards the leaves, flower, and fruit.

The habitat is cultivated ground, waste places, allotments, gardens, cornfields, stackyards, etc. The plant is also, as a halophyte, found in the sand-dune formation in the Sea Couch-grass association, and also occurs on the coast as a strand-plant, nearer the shore.

In habit the one under consideration is erect or prostrate or ascending. The plant is mealy and dark green. The radical leaves are opposite, broadly triangular, or spear-shaped (hence *hastata*), with irregular, coarse teeth, with spreading horizontal barbs,

*The Author.* FIG. 56.—ORACHE (*Atriplex hastata*). *See page* 198.

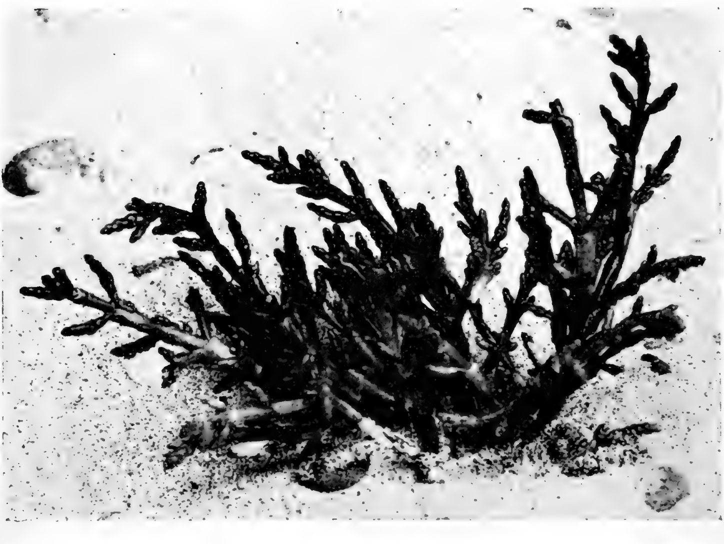


FIG. 57.—MARSH SAMPHIRE (*Salicornia herbacea*).
*Messrs. Flatters and Garnett* (Copyright). *See page* 200.

and acute, entire, or toothed. The upper leaves are lance-shaped, entire.

The flowers are in simple or panicled spikes, which are interrupted, leafy below. The perianth-segments are triangular to rhomboidal, and slightly prickly on the back, longer than the utricle, being united below. The seeds are dimorphic, the larger ones dark brown, rough and flattened, the smaller black and shining, smooth.

Sometimes less than a foot in height, this species may reach a height of 4 ft. It flowers from July up till September, fruit being found in October. It is a herbaceous annual, prolific and difficult to eradicate.

Lacking a corolla the flowers are inconspicuous, and pollination is effected in the main by the wind. As the flowers are unisexual, and the plant is monœcious, self-pollination is precluded, and cross-pollination may be also largely effected by creeping insects. The male flowers have three to five regular perianth-segments, three to five stamens, which are hypogynous, with slender antherstalks, and there is a rudimentary ovary; the female flowers have two perianth-segments or bracts, which are free or united below, no stamens, two slender styles united below.

The utricle is enclosed in the calyx or bracts, which enlarge after the ovule is fertilised, and the utricle may be dispersed by the wind, or fall to the ground.

Fat Hen, Hard-iron, Lamb's Quarters are the only vernacular names.

ATRIPLEX HASTATA.—*Fig.* 56 *shows the form of the leaves, with irregular margin and barbs, also the panicled spikes, leafy below.*

MARSH SAMPHIRE (*Salicornia herbacea*).

Known as Glasswort on account of the use to which the barilla or soda, obtained from the ash by burning the plant, was formerly put, Samphire is perhaps best known on account of its being frequently employed as a pickle. An umbelliferous plant which grows on rocks *Crithmum maritimum* is also collected and utilised in the same way. The name Salicornia refers to the form of the stem which is horn-like (Latin *cornu*, horn). From the allied species *Salicornia radicans*, which is woody, this species is distinguished by being herbaceous (hence *herbacea*). Dr. C. E. Moss has recently distinguished nine fresh species as British which were formerly included in one or other of the above species, or previously unobserved. The species are indeed polymorphic and worthy of extended observations as regards their variation and general life-history.

This species is found in all parts of the British Isles, as far north as the Shetlands and Orkneys, and in Ireland (the other species being absent from the latter), and the Channel Islands.

Salt-marshes or muddy seashores are pre-eminently the habitat of the Marsh Samphires. They are especially abundant in the muddy creeks about Blakeney Point, near Cley, in Norfolk. This species occurs in

the salt-marsh formation in the Glasswort association, in the general salt-marsh association, the Sea Manna Grass association, forming social communities.

Bright green in colour, the habit is erect, the plant being herbaceous, with a slender root, the stem-joints being thickened upwards and marginate, branched, till the branches bear flowers, and are nearly erect, spindle-shaped. The internodes are narrow at each end, bilobed above when dry, the lower woody and slender, the upper being fleshy, rather flattened.

The flowering internodes are in long spikes, cylindrical, stalked, tapering and blunt. There are eight to sixteen flowering internodes in a spike. The flowers, three on each side, are unequal in size, the central one reaching two-thirds the way up the internode or segment. There are two styles and a single stamen (if two one is often rudimentary) and they are exserted in succession. The fruiting perianth has a narrow wing above. The seed is greenish with curled hairs, ovoid or oblong.

Samphire varies in height from six to eighteen inches. It is in flower in August and September, and is a herbaceous annual.

Few flowers are less conspicuous, and they are bisexual. No honey is secreted. The flowers are sunk in deep pits, and must be self-pollinated, or if in water possibly water-pollinated. Wind may play some part.

The utricles fall in water, and are so dispersed.

Marsh Samphire is called Crab-grass (Crabs are

often found in the salt marshes where a matted mass of Samphire and other plants grow), English Sea-grape, Frog-grass, Glasswort, Sea Grape, Sea Grass, Pickle Plant, Saltwort, Samphire, Marsh Samphire, Rock Samphire, Sampion.

Allusion has already been made to the economic value of Marsh Samphire.

SALICORNIA HERBACEA.—*In Fig. 57 the habit of the plant is well shown, with the stem-joints thickened upward, and the long internodes of the flowering spikes.*

SHRUBBY SEA-BLITE (*Suæda fruticosa*).

According to Hooker and Arnott "suæd is the Arabic appellation of one of the species, all of which yield soda." The name Sea-Blite is applied as the plant is a member of the group Chenopodiaceæ, referring to the insipid taste. This species being distinguished from the other species which is herbaceous by being shrubby, forming dense and extensive low thickets by the coast, is called Shrubby Sea-Blite.

This is a rare and local species, which is found only in the south and east of England, on the coasts of Dorset, Essex, Suffolk and Norfolk.

Shingle-beaches, sandy and pebbly shores are the principal habitat of the Shrubby Sea-Blite. It grows also in the salt marsh. In the Blakeney district it grows in the shingle-beach community forming an extensive association at high and low levels, being frequently exposed to the incoming tide. There it plays an important part in the stabilisation of the

*The Author.* FIG. 58.—SHRUBBY SEA BLITE (*Suæda fruticosa*). *See page* 202.

*J. H. Crabtree.* FIG. 59.—SALTWORT (*Salsola Kali*). *See page* 204.

shingle spit, and in the formation of laterals from the main bank, as has been admirably shown by Prof. F. W. Oliver, to whose memoirs on this area the reader is referred. In the same district this species invades the salt-marshes, which form a peripheral zonation to the shingle beach community, occupying a large part of the so-called Marams.

Being shrubby in habit Sea Blite is a tall plant, with a woody erect stem, and numerous, leafy, erect branches. In some places it is of low and spreading habit. The leaves are numerous, linear, blunt, semi-cylindrical, rounded at the base and tip, succulent, dotted with white. Being a halophyte the plant is adapted to physiological drought. It is hairless and more or less bluish-green. But when grown inland plants from the coast which are dark green become more glaucous, in spite of the absence of halophytic conditions.

The flowers are axillary, minute, solitary, or two- to three-clustered, and nearly stalkless. There are three styles, which exceed the perianth. The seeds are black, shining, vertical, smooth.

From 1–3 ft. is the height of the plant. It is in flower between July and September, and is a shrubby perennial.

The flowers are minute, and are apparently in most cases wind-pollinated. This is characteristic of some other maritime plants. In other cases, since insects are not abundant at the coast, self-pollination is the general rule.

Sea Rosemary, Shrubby Stonecrop, are other names by which the plant is known. The old method of making use of barilla or soda has been superseded by the manufacture of soda from salt. Barilla is an impure carbonate of soda and was used for glass-blowing.

SUÆDA FRUTICOSA.—*In Fig. 58 the shrub-like character is shown, with the crowded, linear leaves, and indications of the flowers in the axils.*

### SALTWORT (*Salsola Kali*).

Like the last the Saltwort was one of those plants used for barilla, abounding in carbonate of soda (hence Salsola), and Kali is Arabic for alkali.

Found around all the British coasts the plant is native also in the Channel Islands, being more or less frequent from Caithness to Cornwall.

Sandy seashores, maritime sands and salt marshes are the habitats of the Saltwort. It is one of the strand plants which take the place of a sand-dune formation where no dunes are formed. But it is most typical of the sand-dune formation, perhaps, growing in the loose sand amongst the Marram or Lyme Grass or other sand-fixing plants.

Prostrate at first, the plant is finally ascending. It is a very prickly plant, a character which at once identifies it, for though the Sea Hollies have the same feature their leaves are broad and not linear as in this case. It is herbaceous, smooth or sparingly hairy, rough, bluish-green, rigid, much branched,

wavy, spreading, the stem striped, angular. The leaves are awl-like, linear, ending in a sharp prickle, rough, the lower ones semi-cylindrical, fleshy, enlarged below, bent back. The upper leaves are ovate, triangular, shorter and broader, half-clasping.

The flowers are solitary or few, one to three, with spinous bracts, stalkless, in the upper axils, the perianth-segments hard and tough, as long as the wings which are rounded, broad or narrow, with a membranous margin, rose-coloured, spreading, horizontal over the fruit, shorter than the bracts.

The seeds are brown and adhere to the pericarp.

In height Saltwort varies from 6–18 in. It flowers in July and August, and is a herbaceous annual.

The flowers are minute and not likely to be visited by many insects. The anthers and stigma ripen at the same time, or the latter first, in which case, being dichogamous, cross-pollination is necessary.

The fruit is a utricle, and is enclosed in the five-winged, starlike, enlarged calyx, and by aid of the latter may be dispersed to a distance by the wind, or, in default, fall near the plant itself.

Eestrige, Prickly Glasswort, Kelpwort, Sowdwort, Sea Thrift, are the names bestowed upon this plant. Turner, in citing the first name, quaintly remarks, "I remember now that one Englishman called this herbe Eestrige." Sowd Wort is also applied to the Columbine.

SALSOLA KALI.—*Fig.* 59 *shows the entire habit of the plant, with its awl-like, pointed, prickly leaves, the*

*upper ovate, half-clasping, and the flowers in the axils of the bracts.*

### 62. The Knot-Grass Group.

British representatives of the Order Polygonaceæ include the Knot-Grasses, Docks, and Mountain Sorrel, Buckwheat also being frequently found in this country. Amongst foreign types Rhubarb, universally grown in the kitchen garden, is a well-known species. This is a species of Dock.

Of this Order there are seven hundred and fifty species and thirty genera. They are found, as a rule, in the North Temperate regions, though they extend from the Tropics up to the Poles. Some are Arctic types growing at high altitudes, as Mountain Sorrel and Alpine Bindweed.

Resembling in many respects the last group, they differ from the Goosefoots in possessing annular stipules or ochreæ. In other respects they also show some affinity with the Amaranthaceæ.

Some of the tropical types are climbing plants, tall and woody, or woody shrubs. The majority are herbaceous. The leaves are alternate, simple, entire, or with small teeth. The ochreæ, or sheathing membranous stipules, clasp the stem at the base of the leaf, and form a distinctive feature.

The inflorescence is racemose, partly cymose. The flowers are hermaphrodite, but sometimes unisexual. They are regular, and either cyclic or acyclic. In the cyclic flowers the perianth consists

of two rows of three petaloid, herbaceous segments (sepals). There are two rings of stamens, three in each, opposite the sepals, hypogynous, or perigynous. The styles are three in number. In Mountain Sorrel the parts of the flowers are in twos. In some foreign types the outer stamens exhibit branching or dédoublement. In the acyclic types the perianth-segments are five in number, and there are five to eight stamens and three styles. The sepals may be free or united below, persistent, overlapping in bud. The anthers are two-celled. If a disc is present it is glandular and annular. The ovary is one-celled, the pistil being syncarpous, and is free, ovoid, three-sided, or flattened. The stigmas are pin-headed and very slender. The ovule is solitary, orthotropous, erect. The fruit is a triangular nut, smooth externally, indehiscent, enclosed in the persistent perianth. The seed is erect, with a membranous testa. The embryo is straight and axile or lateral and curved, with mealy endosperm.

The flowers are wind-pollinated, or, as honey is present in some cases, cross-pollinated by insects. The fruits are dispersed by the wind, by the winged perianth. In some types the fruits are hooked and dispersed by animal agency.

There are several plants of economic importance, a powdered root yielding the Rhubarb of the druggist, and a species of Dock, that of the garden. The leaves are acid, as in Sorrel, or astringent. The roots are purgative. Buckwheat, powdered, has been used

for flour, being used as a pheasant food. A blue dye is yielded by *Polygonum tinctorium*. Oxalic and malic acids are yielded by several Docks.

PERSICARIA (*Polygonum Persicaria*).

With its brilliantly coloured perianth-segments Persicaria, so-called from the spotted leaves, is a handsome plant. The first Latin name has reference to the many-jointed stem with nodes (Greek *gonu*, knee), and this is indicated by the name Knot-Grass, which is another name for allied plants.

Persicaria is found in all parts of the British Isles, Scotland, Ireland and the Channel Islands. In the North of England it grows at an altitude of nearly 1500 ft.

Though common in waste places, and cultivated ground, usually damp ground, ditches, roadsides, it is also found in more native habitats in marshes. It grows, moreover, on clay or loam in neutral grassland in wet places in the rush association.

The habit is erect, spreading. The stems are branched, with swollen nodes, smooth or slightly downy, often of a red tinge. The leaves are hairy both sides or woolly below, ovate, lance-shaped, tubercled, stalked, or the upper stalkless, acute, fringed with hairs, with a spot, black or brown, dotted below. The stipules are fringed with hairs, or fine bristles, and loose.

The flowers are in dense, short, terminal and axillary racemes or spikes, numerous, ovate, oblong

*W. E. Mayes.* FIG. 60.—PERSICARIA (*Polygonum Persicaria*). *See page 208.*

*W. E. Mayes.* FIG. 61.—CURLED DOCK (*Rumex crispus*). *See page 210.*

cylindrical, with a cluster of flowers below. They are red or green, not dotted. The flower-stalks are smooth. The perianth has no glands, and is obscurely veined. The segments are red or white, as long as the fruit. The outer anthers open inwards, the inner outwards. There are six stamens as a rule, and two styles united half-way. The fruit is a nut, flattened, gibbous one side, plano-convex, or three-angled, the faces round, and long-pointed, smooth.

Spotted Persicaria is 1–2 ft. in height, flowering from June to October, and is a herbaceous annual.

The flowers are fairly conspicuous, with a coloured perianth, and form a large spike, 20–30 mm. long. The amount of honey secreted is small. When there are eight stamens three are functionless.

The five fertile stamens alternate with the perianth-segments, and the others are opposite the segments. There is a honey-gland below each segment, with honey in an adhesive layer. The style has two branches with a stigmatic knob in each case. The anthers and stigma, which ripen simultaneously, are of the same height, The flower forms a cup when open and the five outer stamens spread out and do not touch the stigmas, the three others coming in contact with the stigmas. The former opens inwards the three others outwards. Self-pollination occurs in flowers with more than the five functional stamens. The anthers open widely being covered with pollen. If insects do not visit the flowers self-pollination is thus possible and seed is set. The flowers are open

in the rain. An insect visitor touches two stamens and a stigma, and an insect which inserts its head once causes cross-pollination, but if more than once self-pollination may occur. The chief visitors are flies and bees.

The fruit, a nut, is dispersed close to the parent plant.

The names by which this plant is known, as given by Britten and Holland, are Dead Arsemart, Crab-grass, Crab's-claw, Cronesanke, Lakeweed, Lover's Pride, Morub, Peachwort, Persicaria, Red Legs, Red Shank, Redweed, Sauch-weed, Saucy Alice, Virgin Mary's Pinch, Willow-Weed.

POLYGONUM PERSICARIA.—*Fig.* 60 *gives a good idea of the habit. Note the swollen nodes, and stipules or ocreæ, fringed with hairs. The dense terminal and axillary racemes are numerous and ovate.*

### CURLED DOCK (*Rumex crispus*).

As the English name implies the leaves have a curly or crisped margin (hence *crispus*).

Curled Dock is a native of all parts of the British Isles as far as the Shetlands, ascending in Northumberland to 2000 ft., occurring also in Ireland and the Channel Islands.

The habitat is waste places, roadsides, ditches, pastures, fields, etc. It also occurs, possibly as a native plant, in the sand-dune formation, in the Sea Couch-Grass association, with Yellow Horned Poppy, Sea Purslane, etc., and in the Star-Grass association,

as well as in the shingle-beach community, occurring besides as a strand plant.

Having a rosette of radical leaves and an erect stem the plant is of the rosette habit. There are few branches, which are short and do not spread. The radical leaves are long, narrow, blunt below, wavy or crisped at the border (hence *crispus*). The upper leaves are not so large, and are narrower, mere bracts in the spike and blunt below.

The flowers are numerous, in whorls, and in front crowded in a long spike or panicle, the branches erect, the whorls close. The ultimate flower-stalks are longer than the perianth. The inner segments are broadly ovate, the enlarged fruiting segments are heart-shaped, blunt, entire, or scalloped, with one as a rule tubercled, the ultimate flower-stalks longer than the perianth. The inner segments are ovate, with an ovoid or oblong coloured tubercle, small and smooth. The fruiting segments are net-veined. The nut is elliptic.

The Curled Dock is 2 to 4 ft. high, flowering from June to August, and is a herbaceous perennial.

The flowers are wind-pollinated as in other Docks. The anthers ripen first. The flowers are hermaphrodite, or there may be male flowers and female, which last are small.

The fruit is a nut which may be dispersed by the wind.

There are no names for this plant except Curled Dock and Common Dock.

Rumex crispus.—*In Fig.* 61 *the root-stock is shown with a radical leaf, curled at the edge and crisped, with a long petiole. The upper leaves become bract-like in the panicle. The flowers are in whorls.*

## 63. The Birthwort Group.

Only two types of the Order Aristolochiaceæ are represented in the British flora. There are, however, some two hundred species, included in five genera, which are mainly natives of the Tropics or Warm Temperate regions. They are not, however, found in the Australian region. Asarabacca and Aristolochia or Birthwort are the British types. In the former the perianth is tubular, curved, with an oblique entire limb. The Dutchman's Pipe is often found in gardens.

The relationship between this order and others is not clear. The group may, however, be compared with the Nepenthaceæ and Rafflesiaceæ.

These plants are mainly herbs or shrubs. Some are climbing plants, or twining lianes. The leaves are alternate, stalked, simple, entire or lobed, heart-shaped. There are no stipules.

The flowers are hermaphrodite, regular, or zygomorphic, epigynous, brown or green, solitary, or in racemes. The perianth is superior, tubular, bell-shaped or trumpet-shaped, petaloid, with the limb three-lobed, or one-lipped, or entire, valvate in bud. The stamens are six to thirty-six, free or united with the style, epigynous. The anthers are nearly stalkless,

free or attached to the style. The anther-cells open inwards or outwards. The ovary is four- to six-celled, inferior, with many ovules in each loculus. There are six styles, which have a stigmatic surface on the inner face.

The fruit is a capsule, septicidal, four- to six-valved, or a berry. The seeds are horizontal, boat-shaped or flattened. The small embryo is surrounded by abundant fleshy endosperm.

Honey is secreted at the base of the flower, the tubular perianth opening by slits in Asarabacca, and the flower is a trap-flower. The Birthwort has no honey. The tubular perianth possesses hairs which can be pushed inwards but not outwards, imprisoning small flies. Pollination is much as in Cuckoo Pint in such cases. Self-pollination is, however, apparently possible and frequent.

Several plants of this Order have been used in medicine, having bitter, acrid properties and some are aromatic. They also have tonic and stimulant principles. Many of the species have been used as antidotes for snake-bites.

The wood consists of longitudinal plates with a central pith, the plates not in concentric circles but in wedges.

### ASARABACCA (*Asarum europæum*).

This plant had the first Latin name applied because it was not used in garlands.

It is very doubtful whether this plant (like Birth-

wort also) is a native plant. The former use of these plants in medicine may indeed be responsible for their occurrence in apparently native habitats.

Asarabacca is found only in England. It has been noticed in Wiltshire, Buckinghamshire, Hereford, Denbigh, Leicestershire, Lancashire, and Yorkshire, which are more or less distant areas, so that the distribution is discontinuous.

Woods and copses are the chief habitat of Asarabacca. It is found also on banks. I have seen it growing in the hedge-bottom, where it is in more or less complete darkness, and a typical shade-plant, all the habitats being shady places.

In habit the plant, which is downy, is creeping, with a fleshy rootstock. The stem and branches are short, with a pair of leaves and scales. The leaves are radical, dark green, rounded, heart-shaped, kidney-shaped, shining, blunt, evergreen.

The flower is solitary, from a short downy scape between the leaves, greenish-brown. The scape is bent back. The three perianth-lobes are pointed, ovate, bent inwards. The flower is drooping. The anther-stalks are awl-like, the alternate ones longer, the connective having a long awl-like tip. The styles are bent back. The stigmas project between the anthers. The fruit is leathery and bursts irregularly. The seeds are boat-shaped, wrinkled on the convex face, with a winged or fleshy raphe on the other side.

The plant is 4 to 6 in. in height, flowering from May to August, and is a herbaceous perennial.

*The Author.* FIG. 62.—ASARABACCA (*Asarum europæum*). *See page* 213.

FIG. 63.—SPURGE LAUREL (*Daphne Laureola*).
*Messrs. Flatters and Garnett* (Copyright). *See page* 217.

The flowers are regular, and are scented with a camphor or resin odour. Honey is secreted at the base of the flower. The stigma ripens first. When the six stigmas are ripe when the flowers open, the twelve stamens in two rows are turned away, then they rise in the centre, and open outwards. The bent-in perianth-lobes at first form a sort of enclosure, as in the trap-flowers, Birthwort, etc. The pollination is effected by flies as in Arum. The flowers are bent down, or lie on the ground, and the pollen may fall on the stigma.

The seeds fall near the plant when the fruit opens.

Asarabacca, Foalfoot, Hazelwort, Wild Nardus, are the vernacular names.

ASARUM EUROPÆUM.—*Fig.* 62 *shows the creeping root-stock and the kidney-shaped, entire leaves. At the base are flower-buds.*

### 64. THE SPURGE LAUREL GROUP.

Of the Order Thymelaeaceæ there are two British species belonging to the same genus. Some five hundred and fifty species are known, which belong to thirty-eight genera. They are found in Temperate and Tropical regions, being especially characteristic of the South African region and Australia.

The group is related to the Sea Buckthorn group, the Australian Proteaceæ, and the Santalaceæ, or perhaps more nearly to members of the Parietales.

The plants are herbs, shrubs, or trees. The leaves are alternate, or opposite, entire, with stipules.

The flowers are as a rule hermaphrodite, sometimes polygamous with the parts regular, in fours or fives. They are solitary in cymes, or heads. The perianth is inferior, tubular, with a naked throat, or with glands or staminodes. There are four to five lobes. The receptacle is hollowed out forming a calyx-tube, and the axis extends around the ovary. The calyx is petaloid like the tube and overlapping in bud. There is a conspicuous or small corolla, or it may be absent. The stamens are as many as (or more than) the outer perianth-segments, perigynous, included in the tube. The anthers are two-celled, and burst lengthwise. The stamens if equal to the perianth-lobes are alternate with them. There is either no disc, or if it is present, made up of scales or glands which are hypogynous. The ovary is free, one-celled, or rarely two-celled, with one pendulous ovule in each loculus, the pistil being syncarpous.

The style is simple, terminal or lateral. The stigma is pin-headed. The fruit is an achene, berry, or drupe, sometimes enclosed in the persistent receptacle; or it may rarely be a capsule. The seeds are pendulous with little or no endosperm. The embryo is straight.

The flowers contain honey at the base of the ovary. The stigma and anthers are mature at the same time. Flies are the chief agents in pollination in the case of flowers with a short tube, bees pollinating

the flowers with a longer tube and butterflies the longest-tubed flowers.

The berries or drupes are dispersed by the agency of birds.

Members of this group have acrid properties, which reside in the tough leathery bark, causing blistering. Mezereon is used in medicine, and the action of the bark or root is very violent. Ropes and paper have been made from the bark of some species, that of *Lagetta lintearia*, the Lacebark tree, being very lace-like. Some European species yield a yellow dye.

### Spurge Laurel (*Daphne Laureola*).

To the Order Thymelaeaceæ belong the tropical Laurineæ, in which the anthers open as in Barberry, including *Laurus nobilis*, Baysweet, the Laurel of the ancients. The name Daphne is applied to signify the resemblance to Laurel—Daphne is the name of a nymph whom the gods changed into a laurel in order to enable her to escape Apollo, and the name Laureola is applied to Spurge Laurel to indicate the same feature as in Daphne. Having some resemblance in habit on a large scale to some of the Spurges the English name is rather appropriate.

In England the Spurge Laurel is fairly general, though nowhere common, and in Scotland is not found in native habitats. It is unknown in Ireland but occurs in the Channel Islands.

Woods, copses, shady places form the principal

habitat, hedgerows by the wayside or the fields being also the sort of place in which to look for the Spurge Laurel. It is found in damp oakwoods on clay and loam, on limestone in ashwoods, and on chalk in beechwoods as well as in chalk scrub.

Spurge Laurel has the shrub habit, having a stem branched from near the base, with leathery bark. The leaves are mainly at the end of the branches, which are erect, devoid of hairs. The leaves are leathery, inversely oblong, ovate to lance-shaped, narrow below, acute, more or less stalkless, crowded at the top of the branches.

The flowers are yellowish-green, funnel-shaped, in clusters or short racemes or cymes, three to five in the axils of the leaves, drooping, with bracts, which are oblong and fall eventually. The flowers are somewhat included. There are complete as well as male flowers. The perianth-lobes are half as long as the tube. The berries are bluish-black, ovoid.

In height Spurge Laurel varies from 2 to 4 ft., flowering from February to April, being one of the earliest flowering plants. It is a perennial shrub.

Honey is secreted at the base of the ovary. Owing to the long tube only long-lipped insects can get at it. Anthers and stigma ripen simultaneously, and the stamens are more or less on a level with the stigma, so that cross-pollination may occur if insects visit the flowers and self-pollination in their absence.

The fruit is dispersed by birds.

The names Dwarf Bay, Fox-poison, Laurel, Copse

Laurel, Spurge Laurel, Wood Laurel, Sturdy Lowries, have been applied to this plant.

The berries are poisonous. The plant is irritant in principle, being used externally.

Daphne Laureola.—*The habit of the plant is shown in Fig.* 63, *being shrub-like, with the leaves at the end of the branches, and the flowers in the axils, drooping, in short cymes.*

### 65. The Sea Buckthorn Group.

Not an extensive group, the Order Elæagnaceæ contains only some seventeen species and three genera, of which only one, *Hippophæ,* is British. Species of *Elæagnus* are often planted in gardens. They afford edible fruits, which are eaten in some regions. The fragrant flowers are very melliferous, and the honey has been used medicinally.

Members of this Order are found in the Northern Temperate and Tropical zones in the Northern Hemisphere. They are related to the Spurge Laurels.

They are trees or shrubs. Many are adapted to dry conditions, growing on the steppes, and are sometimes maritime, having leathery infolded leaves, spines, or reduced shoots to minimise the possible excess of transpiration over absorption. They are also covered with small, silvery, scurfy scales or hairs. The buds are naked. The plants are much branched. The leaves are alternate or opposite, entire, without stipules.

The flowers are in racemes, axillary, in groups,

small, regular, hermaphrodite or unisexual, with the parts in twos or fours. In the hermaphrodite and female flowers the perianth is tubular, as in the Spurge Laurel group, two- to six-cleft, the lobes overlapping or valvate in bud. The perianth in this case may be fused with the ovary. In the male flowers there are two to four lobes united below. The male flowers are in catkins, the fertile ones solitary. The disc, if present, lines the calyx-tube. The stamens are of the same number in the fertile flowers, or in the male flowers twice as many, as the perianth-lobes. They are stalkless on the throat of the perianth. In the fertile flowers the stamens are opposite the perianth-lobes. The anthers are basifixed or dorsifixed. The ovary is one-celled, free, stalkless, and enclosed in the thickened base of the calyx. The style is slender and short. The stigma is awl-shaped, lateral. There is a single erect, basal ovule, which is anatropous. The fruit is a pseudo-drupe, and does not open, being enclosed in the calyx-tube. The seeds have little or no endosperm, and are ascending. The embryo, which is axile, is straight. The cotyledons are thick.

The flowers are pollinated by the wind, the plants being diœcious, with stamens and pistil on separate plants.

The fruit is dispersed by birds.

The Sea Buckthorn has been much planted on the coast, serving as a means of protection against the inroads of the sea.

This group differs from the last in the erect, not pendulous, ovule.

Sea Buckthorn (*Hippophæ rhamnoides*).

Exactly why this plant is named Hippophæ, derived from two Greek words meaning horse and shine, is not clear. It is possible that some other plant was intended by Dioscorides, who applied this name. Pliny says of the plant, "These plants would appear, too, to be remarkably well adapted to the constitution of the horse, as it can be for no other reason than this that they have received their name." Hardoin, however, thinks that the names *hippophæs* and *hippophæston* have another origin, and that they are compounds of *phaos*, lustre, from the brilliance which they are said to impart to cloths, and *hippos* in an augmentative sense, meaning "great lustre." The second Latin name refers to the resemblance of the plant, though not very closely, to the Buckthorn.

Being maritime this plant is found only in maritime counties from York to Sussex, or on the east and south coasts of England. In Scotland and Ireland it is a naturalised plant. It is nowhere common except locally.

Of maritime type the habitat is sandy seashores, stony and sandy places, and beds of rivers and torrents in Central and Eastern Europe. It grows on saline soil in the sand-dune formation in the Marram Grass association and in fixed dune associations forming a dense scrub.

A shrub in habit, having the appearance of a willow (*cf.* the Osier) the plant is thorny, with slender and somewhat drooping branches, or short and spiny. It is covered with a scaly scurf, close and silvery on the underside of the leaves, with none above. The young shoots and flowers have a rusty-looking scurf. The shoots in the axils sometimes end in spines. The leaves lengthen after flowering. They are linear to lance-shaped, alternate, entire, inversely ovate, silvery below, dull green above, and the flowers appear with them on the old wood.

The male flowers are small, in small catkin-like clusters, the females being crowded, solitary in each axil. The perianth is narrowed above. The lobes of the perianth are oblong. The style projects somewhat. The anthers are yellow with short anther-stalks. The fruit, a berry, is round or oblong, orange yellow.

Sea Buckthorn is 1 to 8 ft. in height. The flowers open in May and June, and the plant is a perennial shrub.

The flowers are pollinated by the wind, the plant being diœcious. In the male flowers bracteoles form a hood bending above the stamens in wet weather, and separate when it is dry.

The fruit is dispersed by birds, and caterpillars with orange patches like the fruits feed on the leaves.

The names of the plant are Sea Buckthorn, Sallow Thorn, Willow-Thorn, Wir, Wivule or Wyrvivle.

HIPPOPHÆ RHAMNOIDES.—*In Fig.* 64 *note the osier-*

*The Author.* FIG. 64.—SEA BUCKTHORN (*Hippophæ rhamnoides*). *See page* 221.

FIG. 65.—MISTLETOE (*Viscum album*).
*Messrs. Flatters and Garnett* (Copyright). *See page* 225.

*like form of the leaves, the white, mealy undersides, and the female flowers, which are solitary, in the axils.*

### 66. The Mistletoe Group.

Of the Order Loranthaceæ there is only one British representative, the Mistletoe. But the Order includes five hundred and twenty species and twenty-one genera, which are mainly Tropical.

Though parasitic, or hemi-parasitic, the Mistletoe possesses green leaves. The plant is attached to the host by means of suckers or haustoria, peg-like outgrowths which are driven into the stem. They are regarded as adventitious roots.

This group is related to the Santalaceæ or Bastard Toadflax group. According to De Candolle's system these plants were placed in Calycifloræ.

Mainly shrubs or partly succulent plants the Order consists of evergreen types. They are parasitic on the branches of trees and have jointed branches. The stems are jointed and the branching is sympodial, dichasial in Mistletoe. The leaves are thick, leathery, opposite as a rule, and without stipules.

The inflorescence is cymose, with flowers in groups of threes or twos. The flowers are complete or unisexual. When the flowers are stalked the bract is united to it as far as the base of the next branch. The perianth springs from the border of the hollow receptacle. In some cases there is a calyculus below the perianth. The perianth is either sepaloid or petaloid. It is attached to the ovary wholly or

partially, or forms a border only. The perianth-lobes are thick, two, four, six, or eight, superior, free, or united into a tubular structure. The lobes are valvate in bud. The stamens are as many as the perianth-lobes, attached to the lobes, opposite to them. In some the inner perianth-lobes are absent, when the stamens are fewer, three, two or one. The anthers are one- to two-celled and open by slits, or are many-celled and open by pores. The pollen may be developed in many cells, which are at first separate though later continuous. The ovary is one-celled, and is inferior, sunk in, or attached to, the receptacle. The style and stigma are simple. There is a single ovule reduced to a nucellus and embryo-sac, attached to the ovary. The ovules are not distinct from the placenta. There is more than one lengthened embryo-sac. The fruit is a one-seeded pseudo-berry or drupe, of which the receptacle constitutes the fleshy part. The seed is erect, with a thin testa and abundant fleshy endosperm and a layer of sticky fluid or substance, viscin. The seed in the case of the Mistletoe only germinates in contact with another plant, as Apple, Poplar, etc.

The flowers are pollinated by insects. Birds disperse the fruit.

No properties of economic importance are afforded by the Loranthaceæ, but their botanical interest is very great. A Chilian species of Loranthus yields dye.

MISTLETOE (*Viscum album*).

Apart from its popularity amongst young and old from its association with Christmas festivities, a relic of the older pagan customs (if indeed the plant was, as we are informed, held in veneration, along with the Oak, by the Druids), the Mistletoe is one of the most interesting types of British plants, from its parasitic habit, and dependence upon birds for its distribution.

There is no clue as to the origin of the name Mistletoe,* of which there are many variations. The first Latin name attributed to Pliny is the name for Mistletoe, and is also used for the bird-lime which was prepared from it. A Greek word, *ixos*, has the same significance. There is a Celtic word "givid," meaning shrub, which is said to be cognate with it.

Being parasitical on certain trees the distribution of Mistletoe is somewhat restricted. It occurs, however, in England and Wales generally, but is most common in the west and south, being rarer in the north, and it is not found in Scotland or Ireland. It may be considered most abundant in the counties of Herefordshire, Gloucestershire, and Shropshire.

As a rule the habitat is woods or copses, or when the host-plant is an Apple Tree an orchard. When ound on the Poplar the habitat is hedgerows.

* Unless we derive it, as does Skeat, from the A. S. mistletan, in which tan signifies twig, and mistel from mist, in Old Dutch bird-lime. The name in the fourteenth century was Mystyldene, and the plant was called also *Lignum crucis*.

A shrub in habit the stem is jointed, woody when old, and the branches are succulent, repeatedly forked twice, round in section, knotted. The plant is evergreen, smooth, and succulent, yellowish-green. The leaves are whorled or opposite, narrow to oblong, ovate to lance-shaped, or inversely ovate, blunt, entire, five- to seven-nerved. They are thick and fleshy.

The plant is diœcious. The flowers are stalkless in the axils, clustered. There are about three to five male flowers in a cluster, without a perianth, the parts in threes with two cup-shaped bracts. The female flowers are five in number, green or yellowish, with four perianth-lobes, which are triangular. The stigma is blunt, stalkless, as are the anthers, which are many-celled and open by pores. The fruit is a berry, white (hence *album*), transparent, round, or ovoid, sticky, one-seeded, with a sticky pulp externally. The embryos, which are one to three, are green, and if there are but two they are united by the cotyledons.

In height the mistletoe is 1 to 4 ft., hanging from beneath a branch or growing erect. It is in flower from February to May, and is a perennial shrub. It is said to live as long as forty years.

The flowers contain honey, and are pollinated by bees and flies. The plant may be diœcious or monœcious. The stamens are fused with the perianth-lobes. There are several pollen-sacs.

The seed is sticky, and the layer of viscin prevents the bird from swallowing the seed, which it detaches from the sticky pulp with its bill, and leaves on a

branch to germinate in due course. The sticky layer also serves, since some is left attached to the seed as a rule, to make it adhere to the branch.

The Mistletoe, though hemiparasitic, is partly green. It has been suggested that the plant takes up the ascending sap only, whereas in the non-green parasites the descending sap is utilised. The Mistletoe adheres by the peg-like suckers to the wood of the host-plant and the nutritive material is tapped as it rises. In addition the suckers ramify and penetrate the bast so that descending sap is also drawn upon.

The plant being an evergreen the Mistletoe can also obtain its own carbohydrates during the winter, when the host-plant is itself inactive. This, if the host-plant is benefited, is a case of the mutual relation between the host-plant and the parasite, or symbiosis.

All-heal, Masslinn, Mistletoe are the only names cited for this plant.

Birdlime, as noted, is made from the berries. The dye made from the ashes of the Mistletoe in the fourteenth century was used for making the hair a yellow colour. Mistletoe, Henslow says, has been given to cattle as fodder in winter.

A good deal of folklore has centred around the Mistletoe. Sir J. Colbach says that the Mistletoe was employed "for further and more noble purposes than barely to feed thrushes, or to be hung up superstitiously to drive away evil spirits." Being used as a means of warding off evil spirits, it was one of the

sacred plants held in much veneration, as the Lotus in India and the East, the Myrtle of the ancients, etc.

The Rev. Hilderic Friend cites an author who writes of the Mistletoe as follows: "It is not a matter of surprise that a plant of such peculiar aspect which occurs in such a remarkable position as the Mistletoe, should have awakened the attention of various races, and exerted influence over their religious ideas. It played an especially important part among the Gauls. A remnant of this seems to exist still in France, for the peasant boys use the expression 'An gui l'an neuf' as a New Year's greeting. It is also a custom in Britain to hang the Mistletoe to the roof on Christmas Eve—the men lead the women under it and wish a Merry Christmas and a Happy New Year. Perhaps the Mistletoe was taken as a symbol of the new year on account of its leaves giving the bare tree the appearance of having regained its foliage."

The god Baldur we are told was slain with a branch of the plant. Mr. Friend remarks of this legend: "Frigga had taken an oath of all created things that they would never be employed for the injury of this best of gods, but she had overlooked one little shoot that groweth east of Walhalla, so small and feeble that she forgot to take its oath. This feeble shoot, thus forgotten, was put into the hands of a blind god by Loki, and whilst the other gods were amusing themselves by flinging at Baldur the various things that had taken the oath, Hodur flung the Mistletoe dart,

which pierced Baldur that he fell to the ground. The myth is very interesting, but it is not our duty here to give its interpretation. Everyone knows that it used to be customary to give names and legends to swords in the olden time, and in commemoration of this event more than one sword borne by the champions of the north has been named Mistelteinn (*i.e.* the Mistletoe) by its owner. It was customary, we are told, to cut down the Mistletoe with a golden hook, the branch so cut being specially virtuous in its use against poisons and other evils."

VISCUM ALBUM.—*Fig.* 65 *shows numerous plants growing on the host, an apple tree in leaf, forming a dense bush, the stem growing out at right angles.*

### 67. THE BASTARD TOADFLAX GROUP.

Like the last, so far as Britain is concerned, this group, the Order Santalaceæ, is represented by a monotypic genus, Thesium, with one species, *T. linophyllum.*

The total number of known species is, however, about one hundred and fifty, and there are at least twenty-six genera. Like the Mistletoe also these plants are hemiparasitic, bearing some resemblance to the Loranthaceæ. They are also related to the Olacineæ and Cornaceæ. They are parasitic not only on stems, but also on roots, *e. g.* the British type. From the Spurge Laurel group this group differs in the perianth being attached below to the ovary, and in the valvate segments. Their distribution is

cosmopolitan, as they are found throughout Europe, temperate Asia, and especially South Africa.

Included in this group are plants of herbaceous, shrub, or tree, habit. The types found in New Holland, the East Indies, and South Sea Islands have the tree or shrub habits. The leaves are usually alternate and entire. They do not bear stipules.

The inflorescence is racemose, or forms a head or spike. There may be three flowers forming a cyme in place of solitary flowers, as in the Mistletoe group. The flowers are hermaphrodite or unisexual and are small, with two bracteoles. The perianth is inferior, or adheres to the ovary, being epigynous or perigynous. The disc is epigynous, swollen or lobed. The simple perianth is either sepaloid or petaloid. There are four to five lobes, which are valvate in bud, sometimes bearing on the face a tuft of hairs. In number the stamens equal the perianth-lobes to which they are opposite and attached. The anther-stalks are short. The anthers are basi- or dorsi-fixed. The ovary is one-celled, inferior, the placenta being central with three ovules. The style is short, single. The stigma is frequently lobed (with one to five segments). The ovules consist of a naked pendulous nucellus, with an erect basal column. The fruit is a nut or dry and hard drupe, one-celled, one-seeded, and does not open. The single seed is adherent to the placenta or to the pericarp. There is no testa. The endosperm is fleshy. The embryo is straight.

The flowers contain honey at the base of the ovary.

The anthers, which remain some time, ripen with the stigma. When wet they close at once. Kerner estimated the time in one case to be half a minute.

In the group is included the fragrant Sandalwood, used as a perfume. Astringent properties belong to some members of the group. Some of the exotic species furnish edible seeds.

### Bastard Toadflax (*Thesium linophyllum*).

Theophrastus is the author of the first scientific name. Alcock says it was named from "Theseus, a king of Athens, B.C. 1235, one of the most celebrated heroes of antiquity. Festivals and games were instituted to his memory, and these were still celebrated with their original solemnity in the age of Pausanias and Plutarch, about 1200 years after his death." Sprengel says that "the Thesion of Pliny is the Thesium linophyllum of modern botany, but from Pliny's description there seems little ground for this opinion. The Greek *Theseion* was some plant used to form the crown competed for at the games (called Theseia) just mentioned." The second scientific name refers to the flax-like foliage.

Being restricted to soils derived from chalk or limestone, or calciphile, Bastard Toadflax is confined in the British Isles to England, where it is found in the south, east and west of England, between Norfolk and Gloucester and Cornwall and Sussex. It occurs also in the Channel Islands.

Chalk and limestone or oolite hills forming dry pastures are the habitat of this rare plant. On the chalk it is found on chalk pasture and in chalk grassland.

In habit the Bastard Toadflax is prostrate, then ascending, flax-like (hence *linophyllum*). The short rootstock is yellow, woody, with fibrous roots, which are attached to various other plants. The stems are numerous, spreading in a circle, leafy, simple as a rule, stiff. The leaves are narrow, linear, lance-shaped. Sometimes when the plant is well-developed the leaves are not so narrow, and branched at the base. They are acute or blunt, one-veined and yellowish-green.

The flowers are small, in a terminal raceme, or grouped, the stems branched or simple, stalked, the stalks as long as, or longer than, the flowers, white inside. There are three linear bracts, which are finely toothed, the lower central one longer than the flowers. The bracts are attached to the flower-stalks, and form with two bracteoles an involucre. Each flower is on a separate stalk. The perianth is open, short, persistent, lobed as far as the ovary, being tubular or funnel-shaped, bent inwards in fruit, toothed, the lobes wavy or toothed at the margin, triangular, spreading. The ovary is inferior. The fruit is a nut, small, ovoid, green, narrowed into a short foot-stalk, longer than the perianth, netted, ribbed longitudinally.

The Bastard Toadflax is 4 to 12 in. in height. It

*The Author.* FIG. 66.—BASTARD TOADFLAX (*Thesium linophyllum*). *See page* 231.

FIG. 67.—WOOD SPURGE (*Euphorbia amygdaloides*).
*Messrs. Flatters and Garnett* (Copyright). *See page* 237.

flowers from May to July and is a herbaceous perennial.

The flowers are hermaphrodite. The anthers and stigma are ripe at the same time, the anthers being polliniferous for a considerable period, but sensitive to moisture, closing up quickly.

The fruit is a drupe and crowned with the perianth so that it may be wind-dispersed. Being a hemi-parasite Bastard Toadflax derives some of its nutriment, like Red Bartsia, from the roots of its hosts, but a large part also from the atmosphere, being a green plant and capable of carbon fixation. The suckers are in the form of small, white knobs at the side of the root.

The name cited is the only one by which this plant is known, being given by Dr. Prior in his 'Popular Names of British Plants,' 1863 (third edition, 1879), an excellent guide to botanical names.

THESIUM LINOPHYLLUM.—*In Fig.* 66 *is shown the habit of the plant, the stems spreading in a circle, the flax-like leaves, the flowers in a terminal raceme.*

## 68. THE SPURGE GROUP.

Within the Order Euphorbiaceæ are included, amongst British plants, the Spurges, Box, and Mercury. A type of each tribe is described.

Bentham and Hooker define three tribes: Euphorbieæ, with the involucre calyciform, with many pale monandrous flowers surrounding one

female, and with a minute perianth or none; Buxeæ, with distinct flowers, stamens opposite the sepals, ovules two in each cell; Crotoneæ, with distinct flowers and the outer or all the stamens opposite the sepals, and ovules solitary in each cell.

There are some four thousand species and two hundred and twenty genera. They are cosmopolitan. But they are not represented in the Arctic regions.

The group shows relationship with Malvaceæ and Urticaceæ, in spite of the reduction in the flowers and the structure of the ovary, etc.

Though the British types, except the Box, are herbaceous, a large number of plants of this Order are shrubs or trees. Many of the exotic Euphorbias are adapted to drought, and the South African types are cactoid, with spines. Among Australian types are examples that have the heath habit. In *Phyllanthus* there are phylloclades, and other types resemble the Laurels. A few are climbing plants. A common and characteristic feature is the possession of latex or a milky juice which is narcotic, acrid, or corrosive. If a little of the juice is placed on the tongue a burning, blistering sensation is set up which lasts for some time.

The leaves are variable but usually alternate, sometimes opposite above, alternate below, simple. They sometimes possess stipules, being often deciduous. In place of stipules there are glands or thorns in Jatropha.

The type of inflorescence is variable. The primary

branching may be racemose, the rest cymose. The partial inflorescence may be compressed, and then appears as though there were but a single flower. The flowers are small, and bear bracts or possess an involucre. The plants are diœcious or monœcious. The flowers are regular, hypogynous. The apparent flowers are really flower-heads in Euphorbia. There is no perianth, or if so it is in two whorls; or there may be only one, the calyx; or the flower may be achlamydeous. The parts of the flower are in fives. The male flowers possess one or more stamens. The stamens may be branched or united. The anthers are didymous. There is a rudimentary (or no) ovary. The superior ovary in the female flowers is two- to three-lobed and two- to three-celled. There are one to three styles. The stigmas are compound or simple, entire or lobed. In fruit the carpels separate by an elastic movement both from each other and the axis, opening by two valves. The ovules are one to two, collateral, pendulous from the top of each cell, anatropous, and the panicle is swollen over the micropyle, and covered by a caruncle. The raphe is ventral. The fruit is a schizocarp, or capsule, two- to three-lobed, the cells one- to two-seeded. The seeds are pendulous, the testa crustaceous, albuminous, with much fleshy endosperm, the embryo axile.

Honey is secreted by the moon-shaped glands of the cup-shaped involucre, and is quite exposed. The stamens are jointed (ten to fifteen), being flower-stalks of a reduced inflorescence, and there is a single female

flower in the centre. The stigma ripens first. The anthers close in wet weather. The flowers are pollinated by flies, but bees and wasps visit them. The capsule opens elastically, expelling the seeds.

In this group are numerous interesting types. Many are poisonous, and several of economic importance, as Jatropha, Manihot or Cassava (poisonous but rendered edible by heating), *Hevea elastica* (rubber), Ricinus (castor-oil plant.) The real caper plant, *Capparis spinosa* (Capparidaceæ) of the Mediterranean region, which yields capers (the flower-buds) is sometimes confused with *Euphorbia lathyris*, common in gardens, but native only in woods. The capsules, however, are poisonous. Poison for arrows is obtained by the natives of Africa and America from some exotic Euphorbias. Blisters are caused by the Tirucalli, an Indian species. Gum resin is obtained from some African species, the stems being pierced as in the rubber trees for the juice or sap, which is very poisonous. Pliny says it was called after the physician of King Juba, Euphorbus. The Mannicheel tree is said to be so poisonous that a person sleeping under it dies, whilst a drop of the white juice falling on the skin burns like fire. Tapioca is the starch yielded by the Manihot. Croton yields the cascarilla, a fragrant aromatic bark, and oil is yielded by *C. tiglium*. The Box is poisonous, and boxwood sawdust used in artificial drying of flowers, etc., should be used only with caution. The Dog's Mercury is also poisonous.

WOOD SPURGE (*Euphorbia amygdaloides*).

As the English name implies this species is a native in woods. The name was applied by Turner. The specific name has reference to the almond-shaped leaves.

Local in distribution, Wood Spurge occurs in England generally, being more common in the south. In Ireland it is found near Bandon and Donegal. It is also indigenous in the Channel Islands.

Woods, thickets, shady places, hedgerows, are the habitat of this plant. It is found on clays and loams in the damp oakwood association.

In habit it has the Spurge habit. The rootstock is woody. The stems are erect, reddish, stout, leafy, barren the first year, lengthening the next and giving off branches which bear flowers. The plant is smooth or but slightly hairy. The leaves are alternate, inversely ovate to lance-shaped, entire, blunt or acute. The lower leaves are stalked, and the upper leaves, sometimes oblong, are stalkless. The leaves on the stem are, as is usual, much crowded towards the middle. The upper leaves are not so long and more distant.

The flowers are borne in an umbel of five to ten long rays, which are forked and bifid, or divided nearly to the base into two. The involucres are broad, with slender stalks. The bracts are yellow, rounded, united below into a rounded limb. There may be a few axillary flower-stalks below the ray.

The glands are crescent-shaped or triangular, with long points, which are convergent. The capsule is round, smooth, with minute dots. The seeds are round, or more or less so, and smooth, acute, grey.

In height Wood Spurge varies from a few inches to 2½ ft. It flowers from March to May, and is a herbaceous perennial.

The flowers contain honey which is freely exposed in the glands of the involucre. The anthers ripen after the stigmas, closing when it is wet. Flies pollinate the flowers, but bees and wasps also visit them.

The capsule is explosive, the carpels splitting by an elastic movement away from the axis and contiguous carpels, as in a schizocarp (*cf.* the Mallows).

The names by which this plant is known are Deer's Milk, Mare's Tail, Wood Spurge.

The milk of the Spurges was formerly used as a remedy for warts.

EUPHORBIA AMYGDALOIDES.—*The illustration (Fig. 67) shows the umbel with rays of flowers, the yellow, round bracts, and some axillary flowers below the terminal umbel.*

## Box (*Buxus sempervirens*).

The Greeks called a box made of Boxwood, *puxis* (or *puxos*, box), hence the first Latin name. The second Latin name has reference to its evergreen character.

The Box has a wide distribution in the British

*The Author.* FIG. 68.—BOX (*Buxus sempervirens*). *See page* 238.

FIG. 69.—DOG'S MERCURY (*Mercurialis perennis*), WITH FUNGUS (*Polyporus aculeatus*) IN THE FOREGROUND.

*L. R. J. Horn.* *See page* 242.

Isles owing to its former use as a hedgerow or border shrub, a practice greatly increased with the advent of Dutch gardening. It lends itself very admirably to the shears and to shaping and trimming, an essential in this mode of gardening, better perhaps for permanence than the Yew.

Though widespread in plantations and woods owing to the above circumstance the Box is truly native only in a few English counties, Surrey (Box Hill), Kent, Bucks, and Gloucester. Elsewhere it is only naturalised in shrubberies, etc.

The habitat is chalk downs or oolite hills, where the Box forms a dense wood or scrub. It is found on chalk in chalk scrub.

Box is a shrub or small tree in habit. The wood is close-grained. The branches are erect or drooping. The young branches are downy. The plant is an evergreen. The leaves are alternate, oblong to ovate, thick and leathery, bright green, shining so that snow falls off, blunt or notched. The leaf-stalks are fringed with hairs.

The flowers are green or white, in small spikes, crowded, stalkless. The bracts are blunt. The plant is monœcious. There are several male and one to two female flowers above, in the same cluster in the axils. The male flowers have one small bract below the perianth, there being three in the case of the female flowers. The perianth-lobes are blunt, the perianth being four-cleft. There are four stamens and three styles. The stamens project some distance.

The anthers, ovate to arrow-shaped, are didymous. The ovary is round. The capsule is ovoid, stalkless, three-horned, hard, wrinkled, three-celled, with two black seeds in each cell.

In height the Box, when well-grown, reaches a height of 15 ft. or more. It flowers between April and June, and is a perennial shrub.

Box, being monœcious, cross-pollination must be effected by an outside agency. It is thus wind-pollinated. In the male and female flowers honey, which is exposed, is secreted. The flowers are visited by bees for pollen, and as the Box flowers early it may be pollinated to some extent by insects. The pollen is dry and dusty, and when the hive-bee visits the flower it wets it with honey and brushes it on to its hind legs. The stigma ripens in advance of the anthers.

The fruit opens explosively. The inner layer of the pericarp separates from the outer. The seeds are shot out of the capsule, the valves twisting inwards, then outwards.

The Box is called Dwarf Box, the common form in gardens, Box-tree, Bush-tree, Dudgeon. As to the last name Gerard says "Turners and cutlers, if I mistake not the matter, do call this Wood Dudgeon, wherewith they make dudgeon-hafted daggers."

In the Roman period a *topearius* was one who was employed to cut and clip Box, hence the name topiary. A friend of Julius Cæsar, at the beginning of the first century, invented this art. There was a revival of

topiary in the seventeenth century. It is also much in vogue at the present time.

Being close-grained the wood has been used for a variety of purposes for delicate turnery. In particular it has been much used for mathematical instruments, and for engraving, when wood blocks were in greater demand.

The leaves and bark have been used in medicine. Formerly, by making a decoction from it, hair was tinged an auburn colour.

Like other trees the wood is one of those of which the Cross was said to have been made. It was used in ceremonies on Palm Sunday or the Saturday before.

It is mentioned by Shakespeare:

> "Get ye all three into the Box Tree."

Names of places such as Box Hill in Surrey, Boxwell in Gloucestershire, show that the plant is ancient.

It is used with other evergreens for the decoration of graves. Thus the Rev. H. Friend says: "In several places in the north of England, as we learn from the poet Wordsworth and his annotator, it was customary when a funeral took place to fill a basin with sprigs of Box, and stand it at the door of the house from which the coffin was taken. Each person who attended the funeral was in the habit of taking a piece of the shrub, which he carried to the grave-side, and threw in when the corpse had been lowered."

> "The basin of Box-wood, just six months before,
> Had stood on the table at Timothy's door;
> A coffin through Timothy's threshold had passed,
> One child did it bear, and that child was his last."

BUXUS SEMPERVIRENS.—*The illustration* (*Fig.* 68) *shows the alternate, oblong leaves, which are blunt at the tip. Two fruits may be seen in the axils of leaves.*

### DOG'S MERCURY (*Mercurialis perennis*).

Pliny applied the name "Mercurialis" to this plant, after the god Mercury, who was supposed to have found it to be of medicinal value. The prefix "Dog's" of the English name is an epithet which may denote coarse or harmful, or spurious, as opposed to annual Mercury.

In Britain this plant is general as far north as the Orkneys. It is found in the Highlands at an altitude of 1700 ft. It occurs also in Ireland and in the Channel Islands.

Being a shade plant the habitat is woods, thickets, shady places generally, hedgerows. The plant is found on clay and loam in damp oakwoods, on siliceous soils in sessile oakwoods, on limestone in damp ashwoods, on limestone pavements, in beechwoods, on chalk in chalk scrub, on marls and calcareous sandstones in ash oakwoods. It also occurs in the Arctic-Alpine chomophyte formation.

From the annual Mercury this plant differs in being perennial. The stem is also simple, not

branched as in the former. The flowers are in loose spikes, whereas in the former the female flowers are sessile or shortly-stalked. The former may sometimes be a monœcious plant, not diœcious as in the case of the present species.

In habit the Dog's Mercury is erect. The plant is clothed with hairs. There is a woody rootstock, which is slender and creeping. The stems are simple, solitary, terminal, naked below. The leaves are opposite, crowded above, and larger upward, the upper stalked, oblong, ovate, elliptic to lance-shaped, sometimes broader and shorter, scalloped, coarsely toothed, acute, hairy or rough, green, turning blue when dry. There are very small stipules.

The flowers in the male plants are in racemes, or small clusters, interrupted, in the axils, slender, long-stalked, the flowers stalked and with three acute perianth-lobes. There are eight to twenty stamens. The female flowers are in shorter spikes or racemes of one to three flowers, single or two together, hidden among the leaves. The styles are long, spreading, bent back, with the stigmatic surface all over the front. The ovaries exceed the perianth. They are two-celled. The capsules are warted, hairy. The seeds are grey, with a white cuticle.

The Dog's Mercury is from 8 to 20 in. high. It flowers from March to May, and is a herbaceous perennial.

As the plant is diœcious, as in the last (which is monœcious) pollination must be effected by wind or

insects, and the former is the method. A few male flowers may rarely be found on the female plants. Frequently male and female plants grow in different areas. The pollen is dust-like, as in other anemophilous flowers.

The capsule bursts open, scattering the seeds to a distance. The outer layer of the pericarp is of soft parenchyma. The inner layer is woody and made up of three layers of cells. In the inner epidermis the fibres are at half a right angle to the axis, the next layer having radially elongated cells, and the third layer has cells at right angles to those of the epidermis. The valves open outwards. In the annual Mercury the cells are not so numerous.

Being a widespread plant Dog's Mercury is known by several names, as Adder's-meat, Boggard-flower, Bristol-Weed, Cheadle, Dog Mercury, Dog's Cole, Kentish Balsam, Maiden Mercury, Wild Mercury, Sapwort, Snake's Bit, Snake-weed, Town-weed.

Dog's Mercury is acrid and poisonous. It yields a purple dye. It has been boiled as a spinach. Sheep have been poisoned by it, but when dried it is not harmful.

MERCURIALIS PERENNIS.—*The illustration* (*Fig.* 69) *shows the social habit of Dog's Mercury. Some of the plants show the male flowers in axillary, long-stalked, slender racemes. The leaves are seen to be opposite, more numerous above.*

## 69. The Nettle Group (Summary).

(*Introductory Volume, p. 176.*)

Of the order Urticaceæ there are four British genera—the Elm, Nettles, Pellitory-of-the-Wall, Hop—which are arranged in three tribes: Ulmeæ, with flowers bisexual as a rule, a three- to eight-lobed or -partite perianth. The filaments are slender, straight in bud. The ovary is one- to two-celled. The ovules are pendulous. There is no endosperm, and the embryo is straight. In the Urticeæ the flowers are unisexual. The perianth in the male is four- to five partite, in the female tubular or four- to five-cleft. The filaments are bent inwards in bud with the anthers reversed. The ovary is one-celled. The style is simple or absent. The ovule is erect and orthotropous. The albumen is fleshy or absent. The embryo is straight. This includes Urtica and Parietaria. In the Cannabineæ the plants are diœcious, the males in a panicle, the females in a cluster or spike. The perianth of the male is five-partite, that of the female one scale-like sepal. The anther-stalks are straight in bud. The ovary is one-celled. There are two styles, and the ovule is pendulous. The albumen is fleshy; the embryo is curved; in the Hop the stem is twining; the embryo is spiral.

Hemp is sometimes found in this country.

The Elms are placed in a separate order, Ulmaceæ, by some, and Humulus in another order, Canna-

binaceæ. The Ulmaceæ are distinguished by the inflorescence, the aestivation of the stamens (straight in bud) and the pendulous ovules.

Engler places *Urtica* and *Parietaria* only in Urticaceæ, the former with stinging hairs, the latter without any. So restricted there are only about sixty species and forty-one genera, which are natives of Tropical and Temperate regions.

Including in the group the Elms and Hop, there are one thousand five hundred species and one hundred and eight genera, which range all over the world.

They are related to the Mallow and Spurge groups, distinguished from the latter by the single-seeded fruit, and from the Amentiferæ by the regular perianth in the male flowers. The Fig and Mulberry are members of this group.

In the British types these plants are mainly herbaceous, except the Elms and other trees. The group includes also shrubs. The leaves are rough, sometimes with stinging hairs, opposite or alternate. The stipules are large.

The flowers are unisexual, or rarely bisexual, small, green. The perianth in the males is regular, simple, three- to eight-lobed, or three- to five-partite; that of the female tubular, less divided, three- to five-cleft, with a scale-like sepal. The stamens are of the same number as the perianth-lobes, opposite them, but sometimes not as many. The anther-stalks are straight with the anthers erect, or bent-in in bud, with the anthers reversed. The ovary is stalk-

less, free, or rarely adhering to the perianth, one- to two-celled, with a single ovule. There is a single style or two, or it may be absent. The stigma is pin-headed, or there are two styles, papillose. The ovules are solitary in the cells, erect, orthotropous, or pendulous and anatropous. The fruit is small, one-seeded, indehiscent or rarely succulent. The seed is erect or pendulous, with fleshy or no endosperm.

The flowers are pollinated by the wind, having abundant pollen and long stigmas. They are unisexual. The fruit may be wind-dispersed, as in Elms, or fall near the plant.

Important economic types are Hemp, the Elms, and the Fig and Mulberry.

### Hop (*Humulus Lupulus*).

The Hop is well-known from its use in brewing. The first Latin name refers to its trailing habit, the plant without support growing on the ground (*humus*). Lupulus is from *Lupus*, wolf. Pliny calls the plant Lupus salicarius or Willow Wolf, perhaps from its clinging to willows. It was an officinal name.

General in England, where it is native in the south, the Hop grows in Scotland, but is naturalised north of Renfrew and Elgin, and in Ireland. It is also native in the Channel Islands. In the Highlands it ascends to 1000 ft.

The habitat is hedges, copses, thickets, open woods and roadsides. The Hop also grows on silty soil in the marsh formation.

A twining plant, Hop coils its stems around whatever support it can obtain. Darwin writes thus of its habits: "When the shoot of a Hop (*Humulus Lupulus*) rises from the ground, the two or three first-formed joints or internodes are straight and remain stationary, but the next formed, whilst very young may be seen to bend to one side and to travel slowly round towards all points of the compass, moving, like the hands of a watch, with the sun. The movement very soon acquires its full ordinary velocity. From seven observations made during August on shoots proceeding from a plant which had been cut down and on another plant during April, the average rate during hot weather and during day is two hours eight minutes for each revolution, and none of the revolutions varied much from this rate."

"The revolving movement continues as long as the plant continues to grow, but each separate internode, as it becomes old, ceases to move."

The rootstock is stout. The stem is rough, sticky, with hairs with an anvil-like broad tip, and climbing, tall, tough, with smooth branches. The climbing hooks help to support the plant. The leaves are opposite, stalked, heart-shaped, palmately three- to five-lobed, the lobes ovate, with acute teeth, the upper ovate, smooth, but rough above. The stipules are connate.

The first inflorescence is cymose. The plant is diœcious. The male flowers are in loose panicles or a much branched pseudo-panicle in the upper axils,

*B. Hanley.* FIG. 70.—HOP (*Humulus Lupulus*). *See page* 247.

FIG. 71.—SWEET GALE (*Myrica Gale*).
*Messrs. Flatters and Garnett* (Copyright). *See page* 251.

small, yellowish-green. The perianth is five-lobed. There are eight stamens. The female flowers are shortly-stalked, in the axils, in ovoid or round spikes or heads, or few-flowered pseudo-catkins. The bracts have a membranous border and are large, close, with two stalkless flowers in the axils. The flower-stalks are curved. There are two purple, long, linear stigmas. The perianth, which is a rounded concave scale with resinous glands below, encloses the ovary. The heads in fruit are ovoid, round, yellow. The fruit is an achene, dry, indehiscent, enclosed in the perianth. The seed is pendulous.

The Hop is in flower from July to September. It grows to a height of 4 to 12 ft. being a climbing plant. It is a herbaceous perennial.

The plant is diœcious. The flowers are wind-pollinated. The pollen is scattered slowly owing to the small slits by which the pollen escapes.

The achenes, provided with persistent bracts, which serve as parachutes, are dispersed by the wind.

Though a well-known plant the Hop has few names: Bine, Bur, Hop, Seeder.

The Hop is used in brewing. The tender shoots have been used as a pot-herb and eaten like Asparagus. Hops were introduced from the Netherlands about 1524. Bitter herbs were before this made into a drink and the beverage called Ale, but when Hops came to be used it was called Beer. In Kent and Sussex the master of a hop farm cuts as many slips of hop-bine or hazel-twig as there are bins in the

garden. On these notches are cut from one upwards and each person draws their standing.

HUMULUS LUPULUS.—*Fig. 70 shows the climbing habit, the opposite, stalked, lobed leaves, the cymes of fertile flowers, and the membranous bracts.*

## 70. THE SWEET-GALE GROUP.

This Order, Myricaceæ, is another monotypic group, so far as Britain is concerned, only the Bog Myrtle or Sweet-Gale being native. By some authors it is included in the Amentiferæ, but the flowers are all in catkins and the fruit is drupe-like, being invested with the fleshy catkin-scales.

There is but one genus, which contains some forty species. The affinities are with the Juglandaceæ, which Order includes the Walnut.

They are found in Temperate and Tropical Asia, South Africa, and North America.

They are shrubs or trees, some having a glandular, waxy pubescence. The buds are scaly. The leaves, which are alternate, are simple, and as a rule have no stipules.

The flowers are in axillary, simple or compound spikes, or catkins, short and erect, and are unisexual. The bracts overlap. There is no perianth, the flower being achlamydeous. The male flowers possess two to sixteen stamens, sometimes monadelphous, the anther-stalks being attached to the base of the bract,

free or united at the base. The anthers are fixed by the base, and open outwards. The female flowers have the parts in twos to fours, and have two to four bracteoles. The ovary is stalkless, one-celled. The two styles are lateral, slender, sometimes with two wings, being attached to the bracteoles which are enlarged. The fruit is a nut or stone or drupe, with an exocarp with a waxy secretion, one-seeded. The seeds are erect, without endosperm.

The flowers are wind-pollinated.

The nut may be dispersed by birds.

This group includes several species, which yield a wax obtained by boiling the fruit. Resin, benzoic acid, and tannin are also yielded by the members of this group. The plants are aromatic and fragrant.

The group approaches Elæagnaceæ or Hippophæ in the two-lobed female perianth and drupe-like nut.

### Sweet-Gale (*Myrica Gale*).

The first Latin name was given by Theophrastus, being the Greek name for the Tamarisk. Gale, applied by Bauhin, is of doubtful origin. It may be from the Dutch *gazel*, fire-wood. In Scotland the plant is called Gall or Gall Bush. Gerard called it the English Sweet Willow or Gaule. It was the *Myrtus brabantica* of Dodonæus and Gerard.

The Bog-Myrtle (another name for this plant), is found generally in the British Isles, and in the Highlands occurs at an altitude of 1800 ft. It is rare in south and east England.

Bogs and moors are the habitats of this species. It is found on sandy soil in the wet heath sub-association, on siliceous soils in sessile oakwoods, in the fen association, carr association, fen carr, on lowland moors, valley moors with reed swamp, Beak sedge association, and in grass moor on the upland moors of the Pennines.

Bog Myrtle has the shrub habit. It is erect, or nearly so, fragrant when rubbed, and flowers appear before the leaves. The leaves are inversely ovate to lance-shaped, or wedge-shaped, coarsely toothed towards the tip, broader above, fragrant, resinous, deciduous, downy below, blunt or acute, shortly-stalked.

The flowers are in short, stalkless, erect, reddish-brown catkins, achlamydeous. The male spikes are racemose, crowded, erect, with two spreading, shining, broadly ovate, concave bracteoles. There are four stamens. The anthers are red. The female flower has two to four bracteoles, and two syncarpous carpels having a single, erect, orthotropous ovule. They are shorter than the male flowers and the styles project. The fruit is a small resinous nut, with a waxy exocarp, lens-shaped, attached to the persistent bracteoles.

Bog Myrtle is 2 to 3 ft. high, flowering from June to July, and is a perennial shrub.

As the catkins hang down the pollen is protected. Sometimes, though the plant is usually diœcious, the flowers are complete. The pollen is dust-like, and

the bracteoles catch it when it is dispersed by the wind, and again shaken out.

The nuts are dispersed by birds or may be wind-dispersed.

Bog Myrtle is called Devonshire Myrtle, Dutch Myrtle, Gale, Gales, Gall, Gall-bushes, Gaul, Gawan, Gold, Golden Osier, Golden Withy, Gole, Goule, Gow, Goyle, Moor-Myrtle, Moss Wythan, Myrtle, Burren Myrtle, Scotch Gale, Stinking Willow, Wild Sumac, Sweet Gale, Sweet Willow, Withwind, Withwine.

Gerard says that in Ely people make faggots of it or gaule sheaves to burn in their ovens. The bitter leaves were formerly used as hops. They were also used to scent clothes, and beds were made of the twigs.

MYRICA GALE.—*In Fig. 71 the flowers are shown, appearing before the leaves, in short catkins without a perianth.*

## 71. THE OAK GROUP (SUMMARY).

(*Introductory Volume, p. 186.*)

Under the Order Amentiferæ in the Introductory Volume the Oak, Alder, Beech, Crack Willow, Goat Willow, and Birch were described.

The Order Cupuliferæ includes the foregoing, except the Willows. A further type described here is the Hazel. The Poplars are included (*post*) in the Order Salicineæ, as defined by Hooker.

In the group Cupuliferæ are included three tribes: Betulæ, including the Birches and Alder, with male flowers in pendulous spikes, four or fewer sepals, two to four stamens, female flowers two to three under each side of a catkin-like spike, without a perianth, ovary two-celled, cells with one ovule, two styles, and small compressed fruit covered by the scales of the spikes; Quercineæ, including the Oaks and Beech, with male flowers with four to ten-lobed or -partite calyx, simple filaments, anther-cells connate, female flowers one to three in an involucre of many bracteoles, which enlarges in fruit; the ovary is three- to seven-celled, and there are two ovules in each cell, the fruit being enclosed in a cupular involucre; the Coryleæ, including Hazel and Hornbeam, with male flowers in pendulous catkins, no perianth, stamens included between two bracteoles, anther-cells separate or connate, hairy at the tip, female flowers in pairs, bracts enlarged in fruit, ovary imperfectly two-celled, two ovules, pendulous from one placenta only, fruit enclosed in the thick bracts.

The group contains some four hundred species and ten genera. The plants are natives of the northern hemisphere, northward from North Africa, North India, the Malay, and Darren Mountains of Australia, New Zealand, and Chili. They show affinity with the Juglandaceæ or Walnut group.

Most of the Cupuliferæ are trees or shrubs. The leaves are alternate, and possess stipules.

The plants are monœcious, the male flowers in

catkins. The male flowers are solitary, either crowded or in spikes. They bear bracts. The perianth-segments are one to five or more, unequal, or they may be wanting. There are five to twenty stamens, inserted on a disc or attached to the base of the perianth-segments. The anther-stalks are free or united at the base. The two-celled anthers open inwards. The female flowers are stalkless in an involucre of bracts, free or united. The perianth is united to the ovary, or is wanting, superior, six-lobed. The ovary is inferior, two- to three- or four- to six-celled. The styles are of the same number, with stigmatic papillæ above and on their faces. The ovules are one to two, collateral, erect or pendulous, anatropous. The fruit is indehiscent, one- or two-seeded, situated on, or enclosed in, the hard bracts. There is no endosperm.

The flowers are pollinated by the wind. Most of the types have winged fruits suited to dispersal by the wind.

Many valuable timber trees are included in this group. Some of the fruits, such as the Hazel, are edible. The bark yields tannin.

### HAZEL (*Corylus Avellana*).

It is said by Pliny that *avellana* is from Avellinum, in Campania, where it was first produced, now Avellino, and Hazel-nuts of a special kind are found there at the present time. Corylus refers to the staff used

for driving cattle, being cognate with Koiranos, a commander, in Greek. Hazel is from the Anglo-Saxon *haes*, a behest or order, a stick used to enforce orders.

One may find the Hazel in all parts of the British Isles and in the Channel Islands. It is found at an altitude of nearly 2000 ft. in the Highlands.

Woods, thickets, hedges, are the habitats of the Hazel. It is found on clays and loams in the damp oakwood forming a coppice, on siliceous soils in sessile oakwoods, on limestone in ashwoods, on limestone on limestone pavements, in chalk scrub on chalk, in ash-oakwoods on marls and calcareous sandstones, on upland moors in peat-remains.

A shrub in habit, the Hazel may grow to the size of a small tree, but when coppiced is generally tufted, with numerous branches, radiating from the short stools. It is glandular and downy.

At Eastwell Park, Kent, trees, 30 ft. high with a girth of 3 ft., are found.

The leaves are rounded, heart-shaped, in two rows, unequal below, plaited parallel to the midrib in bud, doubly toothed, or with slight lobes, coarse and downy both sides, with a long, narrow point. The young twigs are glandular and hairy. The leaf-stalk is short. The stipules are oblong, blunt.

The plant is monœcious. The male flowers are in cylindrical, long catkins, which are in a raceme, drooping, with three-lobed bracts. The female flowers are in nearly stalkless heads, ovoid, scaly, bud-like. The

*H. A. Cox.* FIG. 72.—HAZEL (*Corylus Avellana*). *See page* 255.

FIG. 73.—POPLAR (*Populus monilifera*), WITH LOMBARDY POPLAR TO THE LEFT.
*G. B. Dixon.* *See page* 261.

two stigmas are protruding, bright crimson. The ovoid fruit is on a long branch, clustered, woody, with a palmately lobed, unarmed bract or involucre, the husk. It is bell-shaped and spreading.

As a rule the Hazel is 6 to 20 ft. in height. It flowers from February to May, and the fruit is ripened in September and October. It is a perennial deciduous tree.

In some cases the anthers are ripe in advance of the stigmas, in others the converse is the case, which allows of cross-pollination. The half anthers in the stamens are distinct, as though there were eight stamens, not four, and they are enclosed in a three-lobed scale, formed by a main and two lateral bracts.

The nuts are dispersed by squirrels.

There are a number of common names for the Hazel, as Aglet, Beard Tree, Cat-o-nine-tails, Cats-and-Kittens, Cat's-tail, Chats, Cob-nut, Crack-nut, Filbeard, Filberd-tree, Filbert, Hale-nut, Halse, Hasill-tree, Haselrys, Haul, Hazel, Hazel-palms, Hezzle, Lamb's-tails, Leemers, Wood Nut, Nuttal-tree, Nut-tree, Nut Bush, Nut Hall, Nut Palms, Nut Rag, Palm, Pussy-cat's Tails, Rag.

Hazel torches were burned in the days of the Romans at weddings in the evenings to ensure a peaceful and happy union. The Hazel was supposed to have the power of discovering hidden treasure.

Rhabdomancy or divining by the rod (*Virgula divina*) is of ancient origin, and though many kinds of trees have been used, the Hazel was the most

popular. It was held to be efficacious in the finding of water. A Y-shaped twig was held in the hand by the forks and moved in the direction in which water was to be found. Many men got their living by this means, and it is relied on to-day as a sure mode of finding water. There is considered to be some psychic power in the person who wields the twig, which causes it to indicate the position of a spring or natural reservoir. The twig should be cut on Midsummer night or at certain phases of the stars.

A writer says, "In cutting it, one must face the East so that the rod shall be one which catches the first rays of the morning sun, or, as some say, the eastern and western sun must shine through the fork of the rod, otherwise it will be good for nothing."

Notches were formerly cut on a Hazel twig for each wart to be cured.

Conway writes, "Groves of Hazel or of Elm, which thence may have been called Witch-Hazel (and Witch-Elm), were frequently chosen by the Saxons for their temples (see the Saxon word *wig*), the Hazel being one of Thor's trees. So deep was the faith of the people in the relation of this tree to the Thunder God that the Catholics adopted and sanctioned it by a legend one may hear in Bavaria, that on their flight into Egypt the Holy Family took refuge under it from a storm."

The Hazel is a cultivated shrub, which yields the Filberts and Cobs (var. *grandis*) of the garden. Walking sticks, cask hoops, hurdles, crates, etc., are

made from the branches. The knotted roots are used for veneer work. Artists' charcoal is obtained by burning the wood.

CORYLUS AVELLANA.—*In the illustration (Fig. 72) the occurrence of the Hazel as part of the scrub in an oak-wood is shown, the plant growing socially. The general mode of branching and size of the plant is also shown.*

## 72. THE WILLOW GROUP.

There are about 180 species in the Order Salicaceæ, and four genera. Amongst British types we have the Poplars with broad leaves, drooping catkins and fringed scales, and the Willows, with narrow leaves, erect catkins, and entire scales.

They are found in the northern and Arctic regions, but some are Tropical or Subtropical. Arctic types are found in the plant beds of Glacial and earlier age.

These plants have invariably the tree or shrub habit. The leaves are alternate, simple, deciduous, and the stipules are very characteristic and variable. The Salicaceæ reproduce freely by suckers.

The plant is diœcious, rarely monœcious. The flowers are devoid of a perianth, and they are in catkins or spikes. The catkins develop in autumn and exist as buds through the winter. There is an annular, pitcher-shaped, or glandular disc. The male flowers are made up of two, three, or five to thirty stamens in the axils of the bract, inserted below the disc. The anther-stalks are free or united below. The anthers, which are basifixed, open in-

wards. The female flowers consist of two carpels, placed transversely. The ovary is syncarpous, one-celled, stalkless or stalked. There are two short styles; there are two stigmas, entire or two- to four-lobed. The ovules are numerous. The placentæ are parietal. The ovules are ascending, anatropous. The fruit is a capsule, one-celled, opening by loculi, with two valves, which roll back. The seeds are numerous, very small, without endosperm, and provided with a tuft of hairs which conceals them. The embryo is straight.

The honey is half concealed and abundant. As the plants are usually diœcious, pollination must be effected by outside agency, such as the wind or insects. Many insects visit the Willows in the early months and must effect cross-pollination. The activity of the bees amongst the Sallows and Willows is a feature of early spring. The Willows also are sweet-scented, and the yellow anthers are conspicuous. It is not therefore a matter for surprise that in this genus there are many hybrids. The Willows and Poplars are also adapted to pollination by the wind. They flower before the leaves are produced, as a rule. Pollen is abundant. The seeds are dispersed by the wind by aid of the silky tufts of hairs, which serve as parachutes.

The Willows yield useful timber, and Osiers are used in basket manufacture. The Poplars, which are quick-growing trees, are largely planted for ornamental purposes.

POPLAR (*Populus monilifera*).

This is the tree, which is very commonly planted in this country, that has been until quite recently confused with the Black Poplar (*P. nigra*). The latter, however, has leaves with a long, narrow point. The branches are horizontal and so are the catkins. The bole is often covered with knots and is blackish and rough. The Lombardy Poplar is a variety of the true Black Poplar (see Fig. 73).

Though an introduced plant and not indigenous this species is found in all parts of the British Isles.

It is found in moist places, by the sides of rivers and streams, and both on high ground or at lower levels. It is frequent in plantations and often in woods.

One may recognise the tree by its peculiar list. In a number of examples noted the list is towards the east. The trunk is bare for some distance, then the boughs spread out in a pyramidal manner and curve upwards in the direction of the list. The tree is tall, erect, and of rapid growth and short-lived. It has grey bark. The wood is soft and light. The plant is hairless, with glutinous buds. The leaves are rhombic, triangular, or nearly rounded, the lower angles rounded, scalloped, coarsely toothed, tapered at the end, the young leaves silky below and fringed with hairs, the older leaves smooth both sides. The leafstalks are flattened from side to side, slender.

The plant is diœcious. The male catkins are

cylindrical, the scales hairless; the female are not so long, ascending, curved in fruit, the scales shortly-lobed. There are twelve to twenty stamens. The anthers are purple. The stigmas are roundish. The two stigma lobes are short and broad. The capsule is ovoid, stalked, bent back.

This Poplar is 50 to 60 ft. in height and flowers in March, before the leaves. It is a deciduous perennial tree.

The floral mechanism adapts the flowers to pollination by the wind, the plant being diœcious. Pollination must therefore be effected by wind or insects.

The catkins are provided with silky hairs and the seeds are wind-dispersed.

The names given to the Black Poplar are Cat-foot Poplar, Cotton-tree (from the silky appendages), Devil's Fingers, Pepillary or Popillary, Black Poplar, Old English Poplar, Willow Poplar.

The tree is much planted, but is not a timber of any value.

The Black Poplar was said to have been introduced in 1758.

POPULUS MONILIFERA.—*Fig. 73 gives a good idea of the habit of the tree, with its spreading branches. By the side is the Lombardy Poplar, an erect, fastigiate variety of the true* P. NIGRA.

### 73. THE HORNWORT GROUP.

This group, the Order Ceratophyllaceæ, includes one genus only, *Ceratophyllum*, of which there are

three species, which are cosmopolitan in range, found in Europe, Asia, Africa, Arctic North America.

Bentham and Hooker include *Ceratophyllum* in the Order Callitrichaceæ. It differs from the Haloragaceæ in possessing no perianth. By Warming the group is placed in the Ranales, a cohort including Ranunculus,* which the Hornworts resemble in habit and foliage, but the floral structure is entirely dissimilar, though the several perianth-leaves and one free carpel suggest affinity with Nymphaeaceæ. Willis remarks that as in highly adapted aquatic plants the position of the group is uncertain.

There are two British species, of which one is described.

Being aquatic in habit the Hornworts are limp, submerged plants with a slender stem. The stems are cylindrical, branched, and weak when withdrawn from the water, as in other water-plants, falling over when held erect. The leaves are in whorls, stalkless, and possess no stipules. They are forked, and divided into narrow linear segments.

The flowers are solitary, borne in the axils, very small. The plant is monœcious. The flowers are enclosed in a persistent involucre with awl-like lobes, eight- to twelve-partite. There is no perianth. In the male flowers the anthers, which are numerous, are close together, and have no filaments, being oblong. The cells, which are linear, are embedded in a fleshy, blunt, toothed connective. The anthers

* *I.e.*, the heterophyllous and narrow-leaved aquatic species.

burst irregularly. In the female flowers the ovary is one-celled, oblong. There is a terminal style, which is awl-like, and persists. The stigma, which is one-sided, is covered with papillæ. The single ovule is pendulous from the top of the cell, and orthotropous. The fruit, which is seldom produced, is hard and leathery, and does not open. It is tubercled below, with wings or spurs. The seed is pendulous. There is a membranous testa, and the hilum is thickened. The seeds are albuminous, though Hooker says they are not. The cotyledon is two-fid, ovoid, thick, the plumule large, many-leaved, and the radicle is very short.

The flowers open under water and are pollinated by water agency. The stigmas are sticky, and the pollen, containing a tannin-like substance of a protective nature, sticks to them.

The fruits are dispersed by water.

There are no properties of economic value.

### HORNWORT (*Ceratophyllum demersum*).

Even the well-informed botanist in the majority of cases has little or no acquaintance with the Hornwort, for like the aquatic-wading birds, the plant, if one may use the expression, skulks under water, and is seldom visible from the bank of a river or pond, being quite submerged and usually inaccessible. Consequently it is not a matter for surprise that the non-botanist has frequently never

FIG. 74.—HORNWORT (*Ceratophyllum demersum*).
*Messrs. Flatters and Garnett* (Copyright). *See page* 264.

*J. H. Crabtree.* FIG. 75.—FROG BIT (*Hydrocharis Morsus-ranæ*). *See page* 280.

heard of, much less seen, this interesting plant, or its rarer ally *C. submersum.*

The generic name applied by Linnæus has reference to the spiny or horn-like leaf-segments.

Probably the Hornwort from the above reasons has a wider distribution in the British Isles than is generally supposed. It occurs generally in the British Isles, but not in West Scotland or rarely, and in Ireland it is rare. It is found in the Channel Islands.

Pools, ponds, ditches, slow streams, canals, back-waters, shallow margins of lakes, form the habitat of the Hornwort. It is a member of the fresh-water aquatic formation, where it is found in waters relatively rich in mineral salts, in nearly stagnant waters, in the submerged-leaf association.

Aquatic in habit, Hornwort forms dense masses, usually at or near the bottom of the piece of water in which it grows, but being rootless it does not absolutely grow on the mud, but lies half-way up in the water. Willis says that "The plant decays away behind as it grows in front (like *Sphagnum*) so that vegetative multiplication occurs by the setting free of the branches. The old leaves are translucent and horny, whence the common name. Winter buds are not formed, the plant merely sinking to the bottom in autumn and rising again in spring." As in other aquatic plants, the plant is smooth and has no hairs. It is very leafy. The stem is slender and brittle, breaking in the hand. The habit is much

like that of Water Milfoil, with which it might be confused, had not the latter, as a rule, a more robust stem, and a different green tinge and pinkish or purple stems and pectinate foliage, with a pink rachis. The leaves are in whorls, forked twice or three times, with distant teeth or spines. The segments are linear to awl-like, spreading, and the leaves are dark green. The segments of the uppermost leaves are broader and flatter, more rigid.

Apparently the flowers are only formed in shallow water, a fact which has to do probably with the thermal constant and the possibility of effective pollination. The plant is monœcious. The flowers are very small, and have no peduncle, being borne in the axils of the whorled leaves. A whorl of very small involucral bracts encircles each. There is no perianth, unless the bracts be regarded as a sepaloid perianth. There are twelve to twenty oblong anthers in the male flowers on a convex receptacle. They have no stalks. The female flowers, surrounded by nine to ten sepaloid bracts, hypogynous, consist of a small ovoid ovary, with a simple terminal style. The pistil is slender and sticky. There is a single, pendulous, orthotropous ovule. The fruit is an ovoid, flattened achene, which is crowned by the persistent, slender, curved or hooked style. The fruit has no wing, but has a spine on each side near the base; but they may be wanting, and the style may be short, and the surface also may be covered with small points or prickles.

The plant is submerged, and reaches a length of two or three feet. It flowers, rarely, in June and July, and fruits in August. It is a herbaceous perennial.

Pollination in this genus, as in the genera *Vallisneria*,* *Naias*, *Zostera*, and perhaps a few other British types, is effected under water or on the surface, without the agency of insects. The male flowers are in different whorls to those of the female flowers. The latter are below the former.

The anthers are numerous as in wind- or water-pollinated flowers. They break off and float up to the surface. They are provided with a float at the top of the theca. The pollen is abundant, and is of the same specific gravity as water. The anthers have two points at the extremity in which there is a tannin-like substance. Ludwig considers that this protects it from pond snails. In the anthers are air-cells which make them float up to the surface. They contract when mature. The pollen is ejected into the water. The plant assists in the diffusion of the pollen by its own spiral movement. In two hours an angle of 120° is passed through. As the stigma is sticky the pollen will sooner or later become attached to it, and pollination follows. When fruit is formed it is fairly abundant, so that apparently this seemingly precarious mode of pollina-

* This is a Mediterranean plant, but has been found in canals in Great Britain. It was sent to me last year by Messrs. Flatters & Garnett from the Manchester district.

tion is eminently successful. But, as has been seen in other cases, Nature makes wise provision for the perpetuation of species, and seldom errs.

The achenes are dispersed by the agency of water. Many must fall near the plant and germinate in the muddy bottom of lake, ditch, or stream.

Hornwort and Hornweed seem to be the only popular names for these interesting plants.

CERATOPHYLLUM DEMERSUM.—*Fig. 74 gives a good idea of the habit of the plant, the slender stem, whorls of linear leaves, and the long internodes of the main stem.*

## 74. THE PINE GROUP.

The Pines which belong to the Order Coniferæ, including the Scotch Fir and the Yew, are not described in this volume, since they are members of the sub-class Gymnospermæ.

## CHAPTER III.

### MONOCOTYLEDONS (PLANTS WITH A SINGLE COTYLEDON OR SEED-LEAF).

THIS second great class, the Monocotyledons, is so-called because, as indicated above, the seed with the entire embryo possesses a single cotyledon or seed-leaf. It is true that there are Dicotyledons, as amongst the Ranunculaceæ, in which, as in *Eranthis*, there is but one cotyledon, but the proportion of the monocotylous types in the class Dicotyledons is insignificant, and the rest of the characters afforded by each class suffice to distinguish the two. A large proportion, over 30 per cent., of the Monocotyledons is aquatic, and it has been suggested by Henslow that the monocotylous character is a mark of their adaptation to an aquatic habit. It is, at least, significant that several of the monocotylous Dicotyledons are geophilous, as are many Monocotyledons; and that, in some cases, as in the Lesser Celandine, the stomata are situated as in an aquatic plant. Other authorities regard the monocotyledonous habit as due to suppression of one seed-leaf, and so

derived from Dicotyledons. These plants, so far as our knowledge goes at present, appear in time more or less simultaneously with the Dicotyledons. From these reasons, and the difficulty in distinguishing between the possible reduction or the primitive character of certain types of each class, the question as to whether the one is derived from the other, and as to which is the older, if indeed they are not derived from a common primitive or synthetic ancestor, must remain more or less in abeyance. In considering the evidence for and against, however, reference must be made to the works of Miss Sargent, who has done so much work upon the embryology of Angiosperms. Nor must it be forgotten that our knowledge of the early types of these plants preserved in the rocks is at present in a very unsatisfactory condition. This, it is hoped, however, will shortly be remedied by the revision of the Cretaceous plant remains being undertaken by Dr. Marie C. Stopes, who has already succeeded in advancing our conceptions of the plant-life of that period so far that the solution of the whole question may be considered, it may be said, as not far distant.

The leaves in plants of this group are, as in aquatic plants, or geophytes, frequently narrow, with straight or parallel veins, except in Tamus, Paris, as in the Lily group and grasses, etc. Many types, such as the Pondweeds, possess oval leaves, in which the veins are then arc-shaped. In a few types the leaves are round as in Frogbit (*cf.* Ranunculaceæ). The

leaves of the Palms are fan-shaped. In the Cuckoo Pint the leaves are arrow-shaped, and net-veined as in Dicotyledons.

The first leaves are frequently alternate. The leaves are often simple, alternate, and very generally radical, the aerial stems, especially in Liliaceæ, being scapes. The base of the leaf often sheathes the stem as in the Cuckoo Pint, or next leaf as in grasses. The cotyledon may also sheath the stem as in *Alisma*, being then lateral.

The stems are, according to old terminology, endogenous, *i.e.* growth takes place centripetally, not centrifugally as in exogens or Dicotyledons, according to the same nomenclature. But these histological distinctions are not accurate expressions of the actual structure and behaviour of the elements that make up the fibre or wood and bast. Amongst British Monocotyledons the Butcher's Broom is the only type in which wood is developed, the plant being a shrub, whereas the foreign types include many trees as Palms or arborescent types as *Bambusa*.

The vascular bundles are scattered, and not arranged in rings. Instead of there being an inward growth in Monocotyledons, some of the separate bundles are grouped together and pass upwards and outwards, entering a leaf-base, and the lower ends are scattered below, and outwards, ending here and there in a network below the surface. This is, moreover, similar to the manner of distribution in Dicotyledons

in the case of outgoing bundles, the bundles running down the stem and finally diminishing in thickness. In Monocotyledons the apparent so-called endogenous structure results from the curvature of the bundles in the middle. The cambium, well represented in Dicotyledons, is absent, being arrested. The increase in thickness is due to the activity of the pericycle. The pith is disorganised and not central.

As a rule the parts of the flower are usually in threes, but in the Naiadaceæ they are in fours, and in the Glumaceæ in twos and threes. They are never in fives. The perianth is petaloid as in Iris, etc., or wanting. It is superior or inferior. Thus there is a sort of parallelism of development in regard to the position and number of parts between what we find here and in Dicotyledons, which is an argument, amongst others, for their derivation from a common ancestor, later divergence and parallel development exhibiting in different directions common characters, present in the original ancestral series, but of different value owing to the opposite direction in which evolution has led each.

The fruit is largely an achene or nut, sometimes a capsule with small seeds. There is no tap-root in the germinating stage, except in maize, etc. But it does not persist long. The radicle is branching, but adventitious roots are developed. The stem becomes like an inverted cone, as in Nymphæaceæ.

Several modes of classification have been suggested.

According to one arrangement two groups may be made, as follows:

I. *Petaloideæ, with Perianth Petaloid, often Coloured.*

(*a*) Perianth superior; ovary inferior.

Hydrocharidaceæ. Amaryllidaceæ.
Orchidaceæ. Dioscoraceæ.
Iridaceæ.

(*b*) Perianth inferior or wanting; ovary superior.

(*a*) Carpels free—

Alismaceæ, Naiadaceæ.

(β) Carpels united—

Liliaceæ. Araceæ.
Trilliaceæ. Lemnaceæ.
Melanthaceæ. Typhaceæ.
Juncaceæ.

II. *Glumaceæ* or *Glumiferæ, with Glume-like Uncoloured Perianth.*

Cyperaceæ (stems solid). Graminaceæ (stems hollow).

In another arrangement there are three main divisions, dependent upon the character of the leaves and perianth.

I. *Dictyogenæ: Leaves net-veined; Floral Envelopes whorled.*

Trilliaceæ.
Dioscoraceæ.

II. *Florideæ : Leaves parallel-veined ; Floral Envelopes whorled or wanting.*

(*a*) Perianth superior, petal-like ; carpels syncarpous.

Hydrocharidaceæ. Amaryllidaceæ.
Orchidaceæ.
Iridaceæ.

(*b*) Perianth inferior ; carpels apocarpous, or carpels separable when ripe.

Alismaceæ.

(*c*) Perianth inferior ; carpels syncarpous.

Asparagaceæ. Juncaceæ.
Liliaceæ. Eriocaulaceæ.
Melanthaceæ.

(*d*) Perianth wanting, or of four small scale-like parts.

Typhaceæ. Potamogetonaceæ.
Araceæ. Naiadaceæ.
Lemnaceæ.

III. *Glumiferæ : Leaves parallel-veined, persistent ; Floral Envelopes rudimentary or wanting ; Flowers covered by imbricate bract-like scales.*

Cyperaceæ. Gramineæ.

Bentham and Hooker adopt the following grouping.

I. *Perianth none, or of four small sepals or bracts.*

Typhaceæ. Lemnaceæ.
Aroideæ. Naiadeæ.

II. *Perianth wholly or partially petal-like ; Ovary apocarpous.*

Alismaceæ.

III. *Perianth wholly or partially petal-like; Ovary inferior.*

Hydrocharideæ. Amaryllideæ.
Orchidaceæ. Dioscorideæ.
Irideæ.

IV. *Petals regular; Carpels syncarpous; Ovary superior.*

Liliaceæ. Restiaceæ.
Juncaceæ.

V. *Perianth rudimentary or none, replaced by chaffy scales or bracts, enclosing the flowers.*

Cyperaceæ. Gramineæ.

In the system adopted by Hooker in the 'Student's Flora,' followed here, the classification is as follows:

I. *Microspermæ.*

Hydrocharidaceæ.
Orchidaceæ.

II. *Epigynæ.*

Iridaceæ. Dioscoraceæ.
Amaryllidaceæ.

III. *Coronarieæ.*

Liliaceæ.
Juncaceæ.
Eriocaulonaceæ.

IV. *Nudifloræ.*

Typhaceæ. Lemnaceæ.
Aroideæ.

V. *Apocarpeæ.*

Alismaceæ. Naiadaceæ.

VI. *Glumaceæ.*

Cyperaceæ. Graminaceæ.

Engler's arrangement, including only British orders here, is:

| | | |
|---|---|---|
| Monocotyledons. | Pandanales . . | Typhaceæ.<br>Sparganiaceæ. |
| | Synanthæ . . | [Cyclanthaceæ.]* |
| | Principes . . | [Palms.] |
| | Helobieæ . . | Potamogetonaceæ.<br>Naiadaceæ.<br>Juncaginaceæ.<br>Alismaceæ.<br>Butomaceæ.<br>Hydrocharitaceæ. |
| | Spathifloræ . . | Araceæ.<br>Lemnaceæ. |
| | Glumifloræ . . | Gramineæ.<br>Cyperaceæ. |
| | Farinosæ . . | Eriocaulaceæ. |
| | Lilifloræ . . . | Juncaceæ.<br>Liliaceæ.<br>Amaryllidaceæ.<br>Dioscoraceæ.<br>Iridaceæ. |
| | Scitamineæ . . | Not British.† |
| | Microspermæ . . | Orchidaceæ. |

* The orders in square brackets are not British.

† Including Musaceæ, Zingiberaceæ, Cannaceæ, Marantaceæ.

Eichler and Warming make the following divisions:

| | |
|---|---|
| Helobieæ . . . | As in Engler. |
| Glumifloræ . . . | ,, ,, (and Juncaceæ). |
| Spadicifloræ . . | Pandanales, Principes, Synanthæ, Spathifloræ. |
| Enantioblastæ . . | Farinosæ in part. |
| Liliifloræ . . . | Liliifloræ and Farinosæ, omitted *ante*. |
| Scitamineæ . . | As in Engler. |
| Gynandræ . . | Microspermæ. |

Bentham and Hooker in Genera Plantarum include Juncaceæ in another group Calycinæ, making seven not six groups (as in their Handbook).

### *Microspermeæ or Gynandræ.*

As the name signifies, this group includes plants with small seeds. It includes the Hydrocharitaceæ and the Orchidaceæ.

The perianth is in two rows. The inner perianth is petaloid. There is an inferior ovary, which is syncarpous, with one- rarely three- to six-celled placentæ, three parietal. The seeds are minute and do not possess endosperm.

In the group are included some of the most lovely flowers, and the most wonderful that the world has produced, the Orchids. Remains of them are not found in plant-beds until rather recent beds are reached.

In the Hydrocharitaceæ the flowers are regular and unisexual, in the Orchidaceæ they are irregular and hermaphrodite. There are but one or two stamens in the Orchid group, three or more in the Frogbit group. In the latter the fruit is a berry, in the former it is a capsule. The Frogbit group is aquatic in habit. The Orchids include many xerophytes and epiphytes.

## 75. The Frogbit Group.

Of the Order Hydrocharitaceæ there are some fifty-five species, and thirteen genera. Amongst British types there is the Frogbit, Water Soldier, and Canadian Waterweed, each of which is described.

They are Tropical and Temperate in range. The British types are fresh-water aquatic plants. Some foreign types are marine.

Being adapted to aquatic conditions, all are herbaceous, and the leaves are floating or submerged, sometimes ribbon-like. In the Water Soldier the leaves are aerial and partly above water, half-submerged. The buds are several in each leaf-axil. The leaves are opposite or in whorls, convolute in bud, entire.

The plants are diœcious or triœcious. The sexes may be in different flowers, and generally on different plants. The flowers are in the axils, one-flowered in the females, more numerous in the male flowers.

They are, when young, enclosed in one or more (one to three) bracts, forming a spathe. They are

usually regular with the parts in threes. The perianth is in two rows and consists of three or six segments. These may be all petaloid, or the outer three may be smaller and sepaloid, overlapping or valvate in bud. The tube is adherent to the ovary at the base in the female flowers, but there is no tube in the males. There are three to twelve stamens in the male flowers, inserted on the base of the perianth-segments. They are in whorls of one to five. Sometimes those in the innermost whorl are functionless, or staminodes. They are opposite the perianth-segments, when three in number, or in several series if more numerous. The anther-stalks are free or united below. The anthers are adnate. In the male flowers there is a rudimentary ovary. The perianth is superior and six-partite in the female flowers. The staminodes may sometimes be functional. The ovary is inferior, one-celled, and has three parietal placentæ, or is three- to six-celled, with two to fifteen carpels. There are three to six styles, which are two-fid, free or united below. The stigmas are decurrent, entire or two-fid, as many as the carpels. The ovules are numerous, ascending, anatropous, erect or pendulous. The fruit is small, berry-like, one- to six-celled, submerged, opening irregularly, ripening under water. The seeds are numerous and contain no endosperm.

Honey is half-concealed. The plants reproduce vegetatively by hibernacula. The fruits are dispersed by the wind or water.

The group includes the interesting type *Vallisneria*,

in which the flowers are pollinated on the surface of the water.

FROGBIT (*Hydrocharis morsus-ranæ*).

That this is one of the most elegant aquatic plants is emphasised in the first Latin name of Frogbit, coined by Linnæus. The second scientific name and the English name refer to the supposed preference of frogs for the leaves, the margins of which they were said to bite. To whatever cause this be due, it is, however, a mere fiction that frogs bite the leaves.

Found in England generally, Frogbit occurs in Ireland also, but is local there. In Scotland it is not indigenous. Indeed its occurrence in many parts of the country must, it is feared, be regarded as artificial, like that of the White Water Lily, and other elegant water plants. The writer has found that certain dealers in such plants for botanical classes and other clients use ponds and lakes, as well as streams and rivers, as stock ponds for the preservation and propagation of their original supply. For purposes of plant distribution, these artificially dispersed plants are useless, and the practice is to be deprecated unless the dealer announce the fact so that botanists may be on their guard. This method has been adopted by some who take a delight in the propagation of such beautiful flowers. In some cases the practice may be beneficial as tending to preserve rare types endangered in their native habitats. The

precaution suggested should, however, always be taken.

Ponds, ditches, are the habitat of the Frogbit. It occurs in the fresh-water aquatic formation, in waters relatively rich in mineral salts, in still or nearly stagnant waters in the floating-leaf association.

The plant is rootless, or may have fibrous roots. The stems are bulbiferous, stoloniferous, the stolons, which are horizontal, being produced in summer. Hibernacula or resting-buds are produced in autumn, on the stolons. These fall off and winter in the mud, and in the spring float up and form new plants. The leaves are rounded or kidney-shaped, stalked, entire, heart-shaped below, deep green above, purplish below, rather thick and leathery.

The flowers are erect, formed on the surface of the water. The flower-stalks in the male flowers are short, and there are two to three large flowers on long, ultimate flower-stalks, with a membranous spathe at the base of two thin bracts. The three outer perianth-segments are pale green, small and oblong. The three inner are broadly inversely ovate, crumpled. There are three to twelve stamens. The spathe in the female flowers is stalkless among the leaves. The flower-stalk is enlarged at the tip into a short perianth-tube, which encloses the ovary. There are six styles. The stigma is bifid. The fruit is dry, six-celled, and contains many seeds. The prominent cells of the testa swell in water and a spiral thread projects.

Frogbit is a floating type, which is 3–6 in. in height. It flowers in July and August, being a herbaceous perennial.

Frogbit is a diœcious plant. There is honey in the flower, which is half concealed in a scale at the base of the inner perianth-segments. The flowers are conspicuous and attractive to insects. Though pollination may often take place the plant does not seed.

The fruit is a capsule, which is fleshy and dispersed by water.

Frogbit is the only name for the plant.

HYDROCHARIS MORSUS-RANÆ.—*A plant is shown in Fig.* 75 *with the characteristic, kidney-shaped leaves, and in the axils the beginnings of flowers with a flower-stalk from which petals have fallen.*

CANADIAN WATERWEED (*Elodea canadensis*).

As the English name implies, this plant is a native of Canada, from whence it has been derived. It appeared in Ireland in County Down, in 1836. Later, in 1841, it was introduced into England. Miss Mary Kirby of Lubbenham, Leicestershire, found it in Leicestershire and sent the first specimens to Prof. Babington, a relative of the Macaulays of Rothley Temple, Leicestershire.

In the British Isles the Canadian waterweed is generally distributed, but is now on the decrease in some areas.

The habitat is ponds, lakes, canals, slow streams, rivers. The plant is found in the fresh-water aquatic

FIG. 76.—CANADIAN WATERWEED (*Elodea canadensis*).
*Messrs. Flatters and Garnett* (Copyright). *See page* 282.

FIG. 77.—WATER SOLDIER (*Stratiotes aloides*).
*Messrs. Flatters and Garnett* (Copyright). *See page* 285.

formation, in waters relatively rich in mineral salts, in stagnant waters and in slowly flowing waters in the submerged-leaf association.

The name Elodea implies that it is a marsh plant, but it is really aquatic. In the older name Anacharis the somewhat inelegant character is suggested, unless it refer to the fact that the flowers rise up to the surface. The second Babingtonian name Alsinastrum indicates its resemblance to Alsine or Sea Sandwort. The English name Water-thyme also refers to the habitat of the plant.

In colour the plant is dark green and the texture is membranous, transparent. It is submerged. The stems are solid, round in section, branched irregularly and at intervals, semi-transparent, brittle, rooting at the nodes. The plant is but slightly attached by the membranous, long, threadlike roots. The leaves are in whorls, three to four in a whorl, stalkless, blunt or acute, bordered, linear to oblong, with small close teeth, which point forwards, membranous, transparent, with a minute, terminal point. The upper leaves are not so acute as those below. They are spreading at right angles.

The stalkless, solitary, female flowers spring from the axils of the upper leaves. Male flowers have only been found near Edinburgh. The male flowers have a perianth with six segments and nine stamens. The male flower breaks off like a bud, and floats to the surface, as in Vallisneria, when it opens. In the greenish-purple female flowers the tube of the peri-

anth is slender, long, and brings the flowers up to the surface. The flowers are placed in a two-lobed spathe, and there are three to six boat-shaped segments which are spreading, and three staminodes. The anther-stalks are three, awl-like, without anthers. The inner segments are bent back. The stigmas are long, round, fringed, notched, bent back. The style adheres to the tube. When fruit is produced the berry is oblong, one-celled, with few seeds.

A floating plant it grows to a length of 1 to 4 ft., and flowers from July to October, being a herbaceous perennial. In the axils of the leaves are squamulæ, but no true winter buds are formed. Babington writes of this plant, "Our plant is undoubtedly perennial. In a growing plant now (December 22nd, 1847) before me, the old stem is losing its leaves, which have nearly all decayed and fallen off, and appears to be itself on the point of death, but several clusters of young shoots have sprung from it, at the base of which roots are produced. In the spring, each of these clusters will probably appear to be an independent young plant. This may account for the supposed annual duration of some of the species."

As the female flowers in Britain are the only ones produced, save in rare instances pollination does not occur and the plant is propagated vegetatively. For the same reason the fruit does not occur. The plant is triœcious.

American Waterweed, Cat's Tails, Guanner Weed, Raave, Water Thyme, Thyme-weed, are the only names.

ELODEA CANADENSIS.—*Note in the illustration* (*Fig.* 76) *the leaves in whorls, three to four in a whorl; also the long-stalked, female flowers,*

## WATER SOLDIER (*Stratiotes aloides*).

It is uncertain what plant was intended by Dioscorides, who bestowed the first Latin name, but the leaves are sword-like, and the plant is aquatic. The second Latin name refers to the Aloe-like character of the leaves, which are spiny, and this protects them from animals that come to drink in the pools or wet places where it grows.

It grows in the east of England, and from the north of England is dispersed as far as the Midlands. In Scotland and Ireland it is not indigenous but naturalised.

The habitat is ponds, ditches, lakes, fen-ditches. Water Soldier occurs in the fresh-water aquatic formation, in waters relatively rich in mineral salts, in nearly stagnant waters, in the submerged- or nearly submerged-leaf association.

The stems are stoloniferous. The plant is submerged or half-submerged. The stem, which is short, bears roots. The plant floats up to the surface in summer. It sinks again and comes up in August or September. When submerged it gives rise to

axillary shoots, which at the end have big buds. When the plant is again at the surface the buds grow into young plants, which, becoming detached, sink to the bottom and hibernate. The rootstock creeps in the mud, and the leaves are numerous, stalkless, tufted, sword-like, long and narrow, triangular, erect or spreading, rigid, tapering, brittle, spinous, coarsely toothed, with small pointed teeth, deep green, with many nerves, succulent.

The plant is diœcious. The flowers are delicate and white. The male flowers are several in a spathe, stalked, like those of Frogbit, but larger, with twelve stamens or more, the functionless ones (fifteen to thirty) on the outside, with awl-like anther-stalks. The anthers are linear. The solitary female flowers are stalkless in the spathe. The tube is long, enlarged below the middle, with numerous staminodes, a few of which bear anthers. The outer perianth-segments are three-lobed. The ovary is flattened, with a narrow neck. The styles are six, deeply divided nearly to the base. The ovules are anatropous. The fruit is a berry, green, ovoid, flagon-shaped, succulent, six-angled, six-celled, bent down at right angles to the stalks, which are stout and short, in the axils. The carpels separate. The seeds have a mucous coat, and are numerous.

The plant is floating, 6 to 10 in. high. It flowers in July and August, and is a herbaceous perennial.

In the Water Soldier the male and female flowers are on different plants, the plant being diœcious.

The honey is half-concealed among the staminodes, which act as honey-glands in the male and female alike. Male flowers are absent in N. Europe, but are found in Central Europe. Propagation is largely effected by offsets.

The fruit is dispersed by the agency of water.

Though not a common plant several vernacular names are cited for the Water Soldier by Britten and Holland, as Crab's Claw, Fresh-water Soldier, Water House-leek, Knight's Pondweed, Knight's Water Sen-green, Knight's-wort, Knight's Woundwort, Water Pine, Knight's Pondwort, Water Sen-green, Soldier's Yarrow, Water Soldiers.

STRATIOTES ALOIDES.—*The illustration (Fig. 77) gives an excellent idea of the habitat of the plant, and also of its habit, the Water Soldier being a half-submerged type which, however, at certain seasons, is totally submerged.*

### 76. THE ORCHID GROUP (SUMMARY).

*(Introductory Volume, p. 198.)*

Probably no other group of plants contains such beautiful and wonderful types as the Order Orchidaceæ. In the Introductory Volume the Spotted Orchid was selected as a type of the group. In this volume the Bog Orchid, Tway Blade, and Lady's Slipper are described.

The number of Orchids is at least five thousand and there are four hundred genera. They are most

abundant in tropical regions, but are also found in Temperate countries, those found in the latter being, as a rule, terrestrial. The tropical types are largely epiphytic, growing on the stems and branches of trees.

All are perennial in duration. They include land plants, epiphytes, saprophytes. The mode of branching serves as a means of classification. Some are monopodial, where the main axis continues growing, with flowers on the lateral branches; others are sympodial, with terminal inflorescence (acranthous); others are also sympodial with the inflorescence on lateral axes (pleuranthous). The terrestrial orchids are sympodial.

In the case of the saprophytic orchids there are no green leaves, as in the Bird's Nest Orchid. They have a fleshy, much-branched rhizome, with or without roots, used in absorption. Many possess mycorhiza.

Some Orchids are adapted to dry conditions with a reserve store in the form of thickened internodes, or with the bud for the next year developed at the base of the stem, which forms fleshy adventitious roots or tubers which continue during the winter.

In the epiphytic Orchids, which have to resist drought, there are clinging roots which do not respond to the influence of gravitation, but are negatively heliotropic. There are also absorbing roots, and long true aerial roots. The external cells, epidermis, etc., absorb water. The internal cells are used in assimilation. In drought they hibernate, as pseudobulbs, or stem internodes form annually, with the

power of food and water storage. In place of tubers the leaves may be fleshy, as in Vanilla.

Orchids are herbaceous. The leaves are entire, with parallel veins, sheathing at the base, scale-like in saprophytes.

The inflorescence is racemose, or spicate, or the flowers are solitary in the axils of bracts. The flowers are irregular. The perianth is epigynous, superior, in two whorls, irregular, with six segments, three petaloid, two above, one below, the three outer sepaloid, subsimilar. The labellum or posterior petal is generally larger, and used by insects as an alighting stage; and by twisting through 180 degrees it assumes an anterior aspect. There are one or two stamens, serving to classify the different types. Most are monandrous. The stamens unite to form a column with the style, or the axis, bearing anthers and stigmas. In monandrous types there is one anther with two stigmas, with a rostellum or third anterior stigma. The anther is opposite the lip, two-celled, and is persistent or falls at length. The pollen is rarely granular, usually aggregated, and united by threads, and in globular masses or pollinia, which are pear-shaped and stalked (with caudicles), ending in an exposed or pouched gland. Possibly there were once three stamens. The single remaining one is anterior. In Orchis two staminodes also occur. In the two-anthered types, such as *Cypripedium*, the anthers are opposite the petals and there is no rostellum, but a simple stigma (of three con-

fluent stigmas). The stamens in diandrous types are of the inner whorl, and the middle fertile stamen in the monandrous type is a large staminode. The pollen does not occur in pollen-masses and is sticky. The ovary is inferior, one-celled, long and twisted, three-angled, with three parietal placentæ as a rule. The ovules are numerous, anatropous. The stigma has a sticky face, formed by the union of three stigmas, which are opposite the lip and below the rostellum in monandrous types. The capsule is three-valved, with many small seeds. The embryo is fleshy.

Pollination in this group is of the greatest interest. Many variations occur, but in general the method is as follows. For details as to the mode adapted in the different types, the reader is referred to the works of Darwin.

Honey is concealed in the spur. Many insects drill a hole in the latter, which contains sweet sap. An insect alights on the lip, and the pollinia, which are sticky, are removed thereby attached to its head. At the same time the insect displaces the rostellum so that a sticky mass adheres to the insect. The pollinia, when the insect enters another flower, are brought into contact with the stigma, in some cases being at first erect on its head, then becoming more or less horizontal.

The capsules open when ripe, and the seeds are scattered by the wind.

In their floral structure the Orchids are related to the Iridaceæ.

A few of the Orchids, such as Vanilla, are of economic importance. Salep is derived from Orchis. They are, however, more noted for their suitability as cultivated plants.

Four groups have been made by Hooker: Epipendreæ, *e.g. Malaxis*, Neottieæ, *e.g. Listera*, Ophrydeæ, *e.g. Orchis*, Cypripedieæ, *e.g. Cypripedium*.

## Bog Orchid (*Malaxis paludosa*).

Formerly, before the whole country was subjected to drainage and cultivation, there were many areas where the Bog Orchid could be found where to-day it is absent. Unfortunately this applies to the majority of Orchids.

In the first scientific name the softness of the plant is indicated. The English and Latin specific names refer to the habitat.

Found in all parts of the British Isles, the Bog Orchid is now rare, and in Ireland is local. In the north of England it is found at an altitude of 1500 ft. Probably its small size and habit of growth have assisted in preserving it from the collector, so that it is overlooked.

Wet spongy Sphagnum bogs, swamps, form its habitat. It is found on sandy soil in the wet heath association with Beak Sedge, Cotton-grass, Sundew, Butterwort, Heaths, Sweet Gale, Gentians, etc. It occurs also in valley moors on Sphagnum moors in the New Forest area, with Bog Asphodel, etc.

Erect in habit with a small solid bulb, which is above ground like an epiphyte, the stem is five-angular above, swollen, with a sheath of white scales, which give rise to a new plant laterally. The leaves are radical, few (three to four), inversely ovate, oblong, with a fringe of cellular bulbils giving rise to new plants, and hollow, acute.

The flowers are in a long, loose, slender, dense spike, yellowish-green, small, numerous. The bracts are very small. The outer perianth-segments are ovate, or broadly lance-shaped, spreading, and two are upturned or erect, the third turned down. The inner segments or petals are linear, oblong, like the sepals, spreading laterally, with an erect, superior, three-veined lip as long as the petals, shorter than the sepals, acute, concave below, and at the base encircling the columns. There is no spur. The waxy pollen-masses are in two pairs, connected, fixed to a gland at the end of the column, the anther hinged on to its tip. The ovary is on a twisted stalk which untwists when it is ripe.

This is one of the smaller Orchids, 1 to 4 in. high. It flowers from July to September, and is a herbaceous perennial.

In most Orchids the twisting of the ovary causes the upper petal or labellum to be below the two others. In the Bog Orchid there is a double twist, so that the lip is in the position in which it probably occurred in the ancestral Orchids. Pollination is as in other types of Orchids.

*The Author.* FIG. 78.—BOG ORCHIS (*Malaxis paludosa*). *See page* 291.

*The Author.* FIG. 79.—TWAY-BLADE (*Listera ovata*). *See page* 293.

The capsule opens when ripe and the small seed are wind-dispersed.

The English name cited is the only one with which we are acquainted.

MALAXIS PALUDOSA.—*In Fig. 78 note the shape of the leaves and sheath below. The spike is, as shown, long, slender. The perianth-segments are spreading.*

### TWAY-BLADE (*Listera ovata*).

In the first Latin name the name of a British naturalist, Dr. Martin Lister (D. 1711) is commemorated. The second Latin name refers to the shape of the leaves, and the English name to their number. The name Listera was bestowed on this plant by Dr. R. Brown, who first determined the homology of the organs of the flower.

This is one of our commoner Orchids, being found in all parts of the British Isles, including Ireland, and in the Channel Islands. In the north of England it is found at an altitude of 2000 ft.

Woods, usually damp woods, copses, and damp pastures, are the habitats of the Tway-blade. It is found on clays and loams in damp oakwoods, on siliceous soils in sessile oakwoods, on limestone in limestone scrub, on limestone grassland, on limestone pavements, and on chalk on chalk grassland. Where it occurs it is generally sporadic.

In habit it is typically orchidaceous. The stem is solitary and stout. The rootstock consists of a tuft

of thick fibres. There are two or three sheathing scales at the base of the stem, which is round, downy, and sticky above. The two opposite large leaves are broadly elliptic, or broadly ovate, strongly ribbed, situated half-way up the stem.

The flowers are greenish-yellow, in a long raceme, which is slender, and loose. The sepals are deep-green, ovate, rather acute. The petals have a two-fid lip, which is saccate below, twice as long, with two linear and no lateral lobes, and between are terminal lobes, apiculate.

One of our taller Orchids, Tway-blade may be as much as 2 ft. high. It flowers from May to July, and is a herbaceous perennial.

Honey is secreted in a narrow depression in the middle of the lip. The pollen is dry and dust-like. The sticky fluid ejected from the sides of the rostellum, which an insect touches when it thrusts it head into the flower, serves to make the pollinia adhere to its head, and as it withdraws its head the yellow pollinia are thus attached. Small Flies, Beetles, and Ichneumons are constant visitors.

The small seeds are dispersed by the wind on the opening of the capsule.

Bifoil, Double-leaf, Dufoil, Herb Bifoil, Twifoil are other names enumerated in the 'Dictionary of Plant Names.'

LISTERA OVATA.—*In Fig.* 79 *note the pair of opposite ovate leaves, with parallel veins, and the long, slender, loose, raceme of flowers, the long lip saccate below.*

Lady's Slipper Orchid (*Cypripedium Calceolus*).

Amongst the British Orchids the choicest gem and truly exotic in its size and large flowers, the Lady's Slipper is so named from the form of the large inflated lip. The first Latin name is a rendering of this in Greek from *Cypris*, a synonym for Venus, and *podion*, a sock or slipper. In bygone days the name Venus was superseded by Lady when a desire was fostered to replace pagan customs and words by those which were of Christian origin. The name Calceolus is also Latin for slipper, and Dodonæus called the plant Calceolus marianus, which again attests the passion in mediæval times for substituting for pagan apellations names of a religious nature.

Only found in N. Britain, this beautiful species, much sought after by the collector and the hawker, is solely preserved to-day by the owners of the property on whose estate the Lady's Slipper is still to be found, though in decreased numbers.

Dense woods and plantations are the habitat of this orchid, which was always a rarity, and to-day is all but extinct, owing to the causes mentioned.

The plant is downy. The rootstock is creeping, fibrous. The stem is leafy. The leaves are three to four, large, ovate, oblong, ribbed, with a long narrow point, the upper ones lance-shaped.

The flowers are yellowish-brown, large, showy, one or two, or solitary, borne on long flower-stalks. The bracts are leaf-like. The outer segments or sepals

are reddish or dark brown, erect, ovate to lance-shaped, the upper one opposite the lip, broadly lance-shaped, and another of two lateral ones united below the lip. The two petals are dark brown, linear, narrower than the sepals, and the lip is inversely ovoid, not as long as the calyx, large, inflated, slightly depressed below, pale yellow, with purple streaks, with a round upturned end, spreading. The column, which ends in a swollen lobe or deformed stamen, is curved, nearly closing the opening of the lip, is not so long as the petals, the middle lobe ovate, blunt, turned down. There is no spur or rostellum. The ovary is straight. The pollen is granular and sticky.

The Lady's Slipper is 1 to 1½ ft. high, flowering in May and June, and is a herbaceous perennial.

Unlike other orchids Lady's Slipper has two stamens with two cells. In other types these two are functionless, and the one which is functional is here a shield-like structure. The slipper, which is large, is closed by the column and stigma, having but a very small opening. The opening is horseshoe-shaped. Once inside insects can get out only with difficulty. In the attempt they must touch the stigma below the abortive anther. The lip has the border bent inwards, so that insects can best escape by the ends of the opening or horseshoe aperture, and by so doing they touch the anthers and bear off the pollinia to another flower. The pollen is sticky in this type, which causes it to adhere to insects and to the stigma when brought in contact with it.

*H. G. Herring.* FIG. 80.—LADY'S SLIPPER (*Cypripedium Calceolus*). *See page* 295.

*W. E. Mayes.* FIG. 81.—PURPLE CROCUS (*Crocus vernus*). *See page* 299.

The seeds, when produced, are small and wind-dispersed.

The only name for this orchid is the one cited.

CYPRIPEDIUM CALCEOLUS.—*Fig.* 80 *gives an excellent idea of the habit of the plant, with the large, oblong leaves sheathing below, and the large flowers with the inflated lip and long outer segments, the former with a narrow opening.*

## EPIGYNEÆ.

In this group or series, the perianth is in whorls; and, except in the Dioscoraceæ, it is coloured. The ovary is inferior, syncarpous, and three-celled. The seeds are large and contain endosperm.

Included in this group are the Iris group, the Snowdrop group, and the Black Bryony Group.

In the first two the flowers are complete; in the Black Bryony group unisexual. The perianth is six-partite, and petaloid in the Iris and Snowdrop groups. In the Iris group there are three stamens, which open outwards; in the Snowdrop group and Black Bryony group there are six stamens, which open inwards. The ovary is three-celled. In the Iris and Snowdrop groups the fruit is a three-valved capsule; in the Black Bryony it is a berry.

All are herbaceous plants, the Black Bryony being a climbing plant. The veins in the latter are net-veined.

The Yellow Flag was described in the Introductory Volume.

## 77. The Iris Group (Summary).

(*Introductory Volume, p. 202.*)

Of the Order Iridaceæ there are eight hundred species and fifty-seven genera. They are found in the Tropical and Temperate parts of the world. A large proportion belong to the South African and Tropical American regions. Of British types there are five genera: *Romulea, Sisyrinchium, Crocus, Iris,* and *Gladiolus.*

The affinities of the group are with the Orchid Group and Snowdrop Group.

They are perennial, herbaceous plants. There is usually a sympodial epigeal rhizome or tuber, or bulb or corm.

The leaves are in two ranks, folded upon each other lengthwise, and overlapping, or equitant, arranged on opposite sides of the stem vertically, not horizontally, flattened, sheathing the stem.

The inflorescence is terminal, cymose. There may be only one flower, as in the Crocus. The flowers are regular or irregular, complete. The perianth is superior, petaloid, tubular below, the six segments in two rows, sometimes unequal, overlapping, sometimes twisted, and persistent after flowering. There are three stamens, which are epigynous, or inserted on or opposite the outer perianth-segments. The anthers open outwards, and are usually narrow. The ovary is inferior, three-celled, with axile placentæ, or unilocular with parietal placentæ. There is a single

style, which is sometimes trifid and petaloid, as in Iris. The three stigmas or stigmatic lobes are dilated, simple or divided, petaloid or fringed. The ovules are numerous, anatropous. The capsules are three-angled, three-celled, three-valved, opening by loculi, with dissepiments in the middle. The seeds are numerous, with a leathery testa and horny or fleshy endosperm. The radicle points towards the hile.

The flowers are conspicuous, and the petaloid stigmas add to their attraction. Some, as Crocus, are long-tubed, and adapted to butterflies. The flowers contain honey, and insects play their part in cross-pollination.

The small seeds are dispersed, when the capsules are ripe, by the wind.

In this group are included many plants that are ornamental, such as *Ixia*, *Iris*, *Gladiolus*, *Crocus*, the last especially being a popular spring garden flower. Saffron is derived from a species of Crocus. Orris-root is obtained from the rhizome of *Iris Florentina*.

### Purple Crocus (*Crocus vernus*).

Saffron from the shops, derived from *Crocus sativus* (the dried stigmas), has the appearance of threads, hence the name Crocus (Greek, *croce*).

Though common in gardens this species is naturalised only in this country, in England, in Middlesex, Suffolk, Nottingham.

Fields and meadows near rivers are the habitat of the Purple Crocus.

There is no aerial stem. The corm, which has a fibrous sheathing coat of scaly leaves, the fibres slender, reticulate, with a membranous border, is broad and flattened. In the axils buds arise, which produce new corms on the old. The sheaths are torn, dirty brown, and form a tube enclosing the leaves and scape at the base. The leaves are produced at the same time as the flowers (hence *vernus*). They are arranged around the stem with an upper and lower face, or are dorsi-ventral. The tissues have palisade-cells above and spongy parenchyma below. The leaves are rolled up when young to protect them from frost.

There are few (or solitary) flowers, which are violet-purple. The spathe is simple. The corolla has a fringe of hairs in the throat. The perianth-tube is very long. The perianth-lobes are white or purple. The anthers are pale bright-yellow. The stigmas are deep orange, branched, three-fid, with erect, wedge-shaped lobes, toothed or jagged at the end, swollen at the top. The subterranean ovary is stalkless on the bulb, protected from frost. The capsule is on a long slender stalk, half an inch broad. The seeds are rounded, small, and reddish.

In height the Purple Crocus is 3 to 6 in. The flowers appear in April and May. The plant is a herbaceous perennial.

The anthers are ripe in advance of the stigmas. Being long-tubed the flowers are adapted to butterflies, and bees. Honey is secreted by the ovary.

The ring of hairs in the throat of the corolla protects the honey. The honey, however, rises high in the tube so that humble-bees can reach it. The flowers are dimorphic. In the smaller one the stigmas are of the same length or shorter than the stamens. In the large-flowered form the stigmas are longer. The anthers turn outwards. Insects in alighting on the petals to get at the honey touch them with the abdomen, and in flying to another flower the pollen so collected is deposited on the stigma. The capsule opens and the seeds are wind-dispersed.

Crocus was a beautiful youth who fell in love with a nymph, Smilax. For his impertinence the legend has it that he was turned into the golden blooms of this flower (the Yellow Crocus, *C. aureus*, an allied species).

Owing to the time of flowering the Crocus was dedicated to St. Valentine.

CROCUS VERNUS.—*In Fig. 81 several plants are seen growing amongst grass. The leaves are linear, lance-shaped. The long tube of the corolla may be readily seen.*

### GLADIOLUS (*Gladiolus illyricus*).

In the first Latin name the sword-like character of the leaves is indicated.

This is an extremely rare plant, which is found in England only in the New Forest, Hampshire, and Isle of Wight, where it is becoming increasingly rare. It has been suggested that it has been introduced in this country.

Open ground in woods amongst bracken is the habitat of the Gladiolus. It is found in meadows, woods, and on grassy heath on the Continent. The British type differs from the Continental.

In habit the plant is iridaceous. The stem is tall. The ovate corm has bulbils below, and is clothed with fibres, which are nearly parallel, netted above, the openings long and narrow. The sheaths are two-edged. The leaves are slender, sword-like, linear, lance-shaped, not so long as the stem, bluish-green, with a long and narrow point.

The flowers are red, then blue, four to eight, in a one-sided spike. The scape is leafy. The spathes are nearly equal, lance-shaped, with a long, narrow point. The perianth is bell-shaped, curved. The three upper segments are spoon-shaped. The lower three are inversely ovate, pale and have reddish-purple veins. The expanded part of the segments is oblong to lance-shaped, the upper broader and longer than the rest. The basal petal is acute, longer than the blunt lower lateral petal, the edges of the upper petal not covered by the two adjoining ones. The tube is three times as long as the ovary. The stigmas are spoon-shaped, the margins rolled inwards after flowering, narrow below and wider above the middle and fringed above. The anther-stalks are longer than the anthers, which are linear. The capsule is club-shaped, ovate, notched, three-angled, the angles prominent and rounded, short, flattened above. The seeds have a narrow wing.

*The Author.* FIG. 82.—GLADIOLUS (*Gladiolus illyricus*). *See page* 301.

FIG. 83.—DAFFODIL (*Narcissus Pseudo-narcissus*).
*Messrs. Flatters and Garnett* (Copyright). *See page* 305.

In height the Gladiolus is 1 to 3 ft. It flowers in June and July, and is a herbaceous perennial.

The anthers ripen before the stigmas. The tube, which is curved, is short so that the flowers are adapted to humble bees. The flowers are sometimes complete, sometimes female only. Being conspicuous, the flowers are visited by insects, and cross-pollination results.

The seeds, being winged, may be wind-dispersed, being also blown out of the capsule by the wind.

The only names are Corn Flag (used for *G. segetum*), Jacob's Ladder, and around Torquay the name Foxglove is given to the garden forms.

GLADIOLUS ILLYRICUS.—*Note in the illustration, Fig.* 82, *the one-sided character of the flowering spike, with lance-shaped spathes or bracts. The perianth is curved, the segments spoon-shaped.*

## 78. THE SNOWDROP GROUP.

Of the Order Amaryllidaceæ there are about 700 species and seventy-five genera. Amongst British plants are included the Narcissus, Snowdrop, and the Snowflake.

These plants are found in the Tropical, Subtropical and Temperate regions. The group is related to the Liliaceæ, but the ovary is inferior. The Amaryllidaceæ are also related to the Iridaceæ, but have six stamens, not three.

Natives of dry climates, they exhibit adaptations for resisting drought, and are largely xerophytic. The Agaves, for instance, have thick fleshy leaves with a waxy covering. A large number have a bulbous rootstock, and in this case produce leaves only in the wet seasons. In other cases the stem is leafy. The leaves, which are radical, are parallel-veined and as a rule narrow.

The inflorescence is cymose or may, in form, be like an umbel or a spike. There is a naked scape and a spathe. The flowers are regular, or irregular, hermaphrodite. They bear bracts. The perianth is superior, petaloid, and made up of six segments, in two whorls, and the mouth of the tube may be formed into a corona, as in Narcissus, which is regarded as the combined ligular outgrowths of the perianth leaves, or as the stipules of the stamens. There are six stamens, which are rarely epigynous and seated on the perianth-tube or base of the segments. The anther-stalks are free or united at the base. The anthers are linear, oblong, turned inwards, versatile, opening inwards or by terminal pores. The ovary is inferior, or adherent to the perianth-tube, ovoid or rounded, three-celled, consisting of three carpels, with axile placentæ. The style is slender or columnar. The stigmas are one or three. The ovules are numerous, anatropous, in two series, in the inner angles of the cells. The fruit is usually a capsule, sometimes a berry, and fleshy, three-celled, three-valved, opening by loculi,

the cells one- (or more) seeded. The seeds are swollen or flattened, with fleshy endosperm.

Honey is produced in the Narcissi and Snowdrop, sweet sap in the Snowflake. The flowers are visited by insects and cross-pollinated.

Like the last group the Snowdrop group includes many plants that are ornamental garden flowers. Textiles are yielded by the Agaves, and pulque, a liquor.

These plants possess emetic, narcotic, and poisonous properties.

### DAFFODIL (*Narcissus Pseudo-narcissus*).

From the Latin specific name (false Narcissus) we obtain some notion as to the meaning of the first. The name Narcissus was given to the plants of this genus by Theophrastus. Narcissus was the name of a beautiful youth, who was changed into a plant on account of his self-love. According to Pliny it was so-called, not after Narcissus, but from *narce* (torpor) because of its effects. Theis says the same. Pamphilus also remarks that Proserpine was gathering Narcissi before Narcissus was born.

Like most other beautiful flowers that find a place in the garden, doubt attaches as to whether this plant is native or not. But many flowers of this type have been so long cultivated and so frequently naturalised that they now have all the appearance of being native in many places.

There appear to be parks in England where the plant is native where it is very abundant, but it is frequently only naturalised, soon becoming established in meadows. In Scotland and Ireland it is only naturalised.

Open woods, copses, mountain pastures, and meadows, are the habitat of the Daffodil. It is found on clays and loams on neutral grassland.

> "A host of golden Daffodils ;
> Beside the lake, beneath the trees,
> Fluttering and dancing in the breeze."
>
> —(*Wordsworth.*)

In habit Lily-like (hence Lent-Lily) the Daffodil has a large bulb with membranous outer scales. The leaves are two to three, bluish-green, nearly flat, with a blunt keel, blunt.

The scape is longer than the leaves, two-edged, one-flowered. The flower is large, not scented, solitary, bell-shaped, yellow, on a short stalk, further in the spathe. The acute, ovate or oblong perianth-segments are hardly longer than the tube, which is wider above, bell-shaped, or broadly tubular, the margin crisped, scalloped, obscurely six-lobed. The capsule is top-shaped.

Rarely exceeding a foot in height the Daffodil, which is a herbaceous perennial, flowers in March, April and May.

Shakespeare, in the "Winter's Tale," rightly fixes the time of blooming.

Daffodils,
"That come before the swallow dares, and take
The winds of March with beauty."

So too, Anna Warner in "Daffy-down-Dilly."

"Daffy-Down-Dilly came up in the cold,
Through the brown mould,
Although the March breezes blew keen on her face,
Although the white snow lay in many a place."

The tubular crown forms an opening to the flower-tube, at the base of which honey is secreted in three honey-glands. This opening is about an inch long, and is wider at the crown, allowing insects to enter bodily. Those that have a proboscis of 6 mm. can thus reach the honey. The stamens are not so long as the pistil, hence insects touch the latter first, and afterwards they are dusted with pollen. There is thus provision for cross-pollination. The flowers are conspicuous; but being early-flowering they are not visited so much as other flowers, which are less conspicuous and that flower later, and little seed is set.

The capsule is leathery, and when ripe the seeds, which are set free on the opening of the valves, may be wind-dispersed.

Quite a large number of names are given by Britten and Holland for the Daffodil, as Affadil, Affoodile, Asphodel, Averill, Belle-blome, Bellflower, Bellrose, Bulrose, Butter-and-eggs, Cencliffe, Chalice-flower, Churn, Cowslip, Yellow Crowbells, Daffadilly, Daffa-down-dilly, Daffodil, Daffodilly, Daffy, Dilly,

Downdilly, Giggary, Glens, Gracy Day, Gregories, Haverdrils, Hen-and-chicks, Julians, Lent-cocks, Lentils, Lent Lily, Lent Roses, Lide Lily, Easter Lily, Yellow Lily, Primrose Peerless, Queen Anne's Flowers.

The Rev. Hilderic Friend writes, "The Anglo-Saxon name for March is Hyldmonard, which, in the west of England was corrupted into Lide, in which form it still lives on in some old proverbs, as well as in the name Lide Lily, by which the Daffodil or Lent Lily is intended."

In Devonshire the Daffodil is called Lent Rose, Lent Lily, Lent-a-Lily, and Lents. In the plural Daffodils are called Lents, Lent Roses, Lent Rosen, Lent Lilies, Lentils, the last by confusion with the Lentil.

The name Lent-cocks is "in allusion, it seems, to the barbarous custom of cock-throwing, which was prescribed by our forefathers for Lent, or rather for Shrove Tuesday, the boys, in the absence of live cocks to throw sticks at, practised the art of decapitation on the flower."

In Devonshire to carry a single flower of a Daffodil, the first of the season, into the house was regarded as unlucky.

Children repeat these lines :

"Daff-a-down-dill
Has now come to town
In a yellow petticoat
And a green gown."

In Devonshire there is a superstition as to the plucking of single flowers and the prosperity of the farm produce, as to which a writer says:

"A friend was staying at a farm-house near Christow, and one day plucked a Daffodil and placed it in his button-hole. On his return he laid the flower on the table; but the servant coming in soon after, demanded who had brought in that daffodil, adding, 'We shall have no ducks this year.'" The writer adds, "A single flower is unlucky for the ducklings; but if a handful is brought in, it is in their favour, and the season will be fortunate."

Daffodils as Lents or Lent Lilies are sold in Lancashire for pins. The name Daff-a-down-dillies we owe to Spenser.

> "Strew me the green round with Daff-a-down-dillies
> And Cowslips, and King-cups, and loved Lilies."

NARCISSUS PSEUDO-NARCISSUS.—*In Fig.* 83 *note the flat blunt leaves. The edge of the corona is frilled. Within it are seen the stamens and stigma.*

SNOWDROP (*Galanthus nivalis*).

In the English name Snowdrop is suggested the pure white drooping flower. The Latin names refer to the same character or colour, milk-like or snow-like.

One might also regard the Snowdrop as a national flower. It is so generally grown and so well-loved. But it is hardly native, save perhaps in Hereford, and Denbigh. Though not native save in these

areas it is generally naturalised, however, in most districts, in England, Scotland, and Ireland.

Meadows, fields, shady pastures, woods and copses, especially the latter, form the habitat of the Snowdrop. In plantations and shrubberies it is sometimes very abundant. The wild form has single, not double, flowers, and is taller, with longer leaves.

Tufted in habit when old, and when several plants are growing together, the Snowdrop has a small ovoid bulb. There are two bluish-green, narrow, broadly linear, keeled, blunt leaves, rarely three, which lengthen after flowering is over.

The scape is longer than the leaves at first and in fruit lies prostrate. The flower is solitary, drooping, white, on a short stalk, above the terminal, two-fid, two-nerved, spathe. The inner perianth-segments are green. The outer are oblong or inversely ovate, concave, white. The segments are distinct down to the ovary.

The inner segments are half as long as the outer, tipped with green. The capsule is ovoid and herbaceous. There are few seeds, which are nearly round, with a soft white testa.

From 6 to 10 in. in height, and a herbaceous perennial, the Snowdrop flowers from February to April.

In his ode to a Snowdrop Wordsworth writes:

> "Nor will I then thy modest grace forget,
> Chaste Snowdrop, venturous harbinger of spring,
> And pensive monitor of fleeting years."

*B. Hanley.* FIG. 84.—SNOWDROP (*Galanthus nivalis*). *See page* 309.

*The Author.* FIG. 85.—SNOWFLAKE (*Leucojum vernum*). *See page* 313.

Montgomery calls it

"The morning star of flowers,"

and further writes of it:

"Winter's gloomy night withdrawn
Lo! the young romantic hours,
Search the hill, the dale, the lawn
To behold the Snowdrop white start to light.'

The stigma and anthers ripen at the same time The stamens are not as long as the pistil. Honey is secreted by the green inner perianth-leaves, but is not abundant. Hive-bees are the chief visitors. As the flowers are drooping the honey and pollen are protected from rain. The anthers, which end in rigid points, form a cone. A bee touches these points and disturbs the stamens, causing the pollen to fall on it. If insects do not visit the flower the anther-stalks unbend, the anthers open and pollen falls on the stigma, which is sticky, and self-pollination results.

The capsule when ripe opens and releases the seeds, which fall near the plant.

Candlemas Bells, Fair Maids, Fair Maids of February, French Snowdrop, Purification Flower, Snow-flower, and White Ladies are names given to the Snowdrop.

In the name Snowdrop, the word "drop" denotes a snowy drop for wearing as an ear ornament. It was regarded as a sacred flower piercing the snow (French, *perce-neige*). It was dedicated to the Virgin Mary.

When the image of Mary was removed from the altars, on a certain day each year, its place was strewn with the emblems of purity and chastity, or Snowdrops. It is the emblem of Our Lady on February 2nd, the Feast of the Purification of the Blessed Virgin.

> "The Snowdrop in purest white arraie,
> First rears her hedde on Candlemas daie."
> (*An Early Calendar of English Flowers.*)

The Snowdrop was sacred to virgins and often placed around old monastic buildings.

> "A flow'r that first in this sweet garden smil'd
> To virgins sacred, and the snowdrop styl'd."
> (*Tickell.*)

It was the emblem also of consolation and hope.

Mrs. Latham writes:

"Hearing a child violently scolded for bringing into the house a single Snowdrop, which the mother called a death-token, I asked her why she gave this pretty flower so bad a name, and was informed that it looked for all the world like a corpse in its shroud, and that it always kept itself quite close to the earth, seeming to belong more to the dead than to the living. Why she believed that a single one brought death with it, whilst she regarded any larger number of them as harmless, she did not explain."

GALANTHUS NIVALIS.—*In the illustration, Fig.* 84, *a clump of snowdrops of the double-flowered garden variety is shown. Note the tufts of leaves and the white outer perianth-segments.*

### Spring Snowflake (*Leucojum vernum*).

As there are two Snowflakes, one which flowers early in spring (hence *vernum*), and the other in summer (*L. æstivum*), this one is called Spring Snowflake. The name Snowflake refers to the white flowers, and Leucojum means white violet.

Like the last this is a frequent garden flower, and is not native, being no more than an alien or denizen in the opinion of Watson, the pioneer of plant distribution in the British Isles. It is found in Dorset, where it is naturalised, near Bicester and Bridport.

Copses are the habitat of the Spring Snowflake, which is a rare plant, though found in plantations and shrubberies or in the garden.

Similar in habit to the Snowdrop, the plant is bulbous. The leaves are more numerous, more or less in two rows, appearing like the flowers in spring.

The scape is hardly winged, with one to two flowers, greenish-white, drooping. The spathe is two-fid above. The ovary is rounded. The seeds have a caruncle. The plant is smaller than the Summer Snowflake.

The height is from 6 to 12 in. high. The plant flowers in April and May, and is a herbaceous perennial.

The honey is not free. The flowers possess, however, a sweet sap in the tissues which are pierced by insects to obtain it. Being pendulous, if insects do not visit the flowers, they are self-pollinated as in the case of the Snowdrop.

The fruit is a capsule, and when ripe it opens and the seeds fall near the plant.

Butter-and-eggs is the only other English name for this plant.

The name denotes the time of flowering as in the Whitlow Grass and other spring flowers.

LEUCOJUM VERNUM.—*The leaves are shown in part in Fig.* 85. *As a rule there are one to two flowers, but here three are borne on the scape. The scape is bifid above.*

### 79. THE BLACK BRYONY GROUP.

(*Introductory Volume, p. 209.*)

Of the Order Dioscoraceæ, which includes the Black Bryony only amongst British plants, there are some 170 species and nine genera.

They are found in the Tropical and Warm Temperate regions, mainly in the former. Amongst the exotic types is the Yam.

There appears to be affinity between this group and Smilaceæ.

In this group many of the plants are climbing plants, others are shrubs. The stem twines to the left. The rootstock is tuberous or woody, or a rhizome. The leaves are net-veined, contrary to the usual rule in the Monocotyledons. They are alternate, often arrow-shaped.

The inflorescence is racemose. The flowers are unisexual, the plant diœcious as a rule, regular, incon-

spicuous, in axillary panicles, or racemes. The perianth is superior in the female flower, petaloid, tubular below, with six segments, in two series, persistent, regular. There are six stamens in the male flowers, or three stamens and three staminodes, inserted on the base of the perianth-segments. The anthers open inwards. The ovary is inferior, trilocular, the placentæ axile or parietal and unilocular. There are three short styles, and the stigmas are entire or lobed. There are two ovules in each loculus, or one to three, anatropous one above the other, erect or collateral. The fruit is a capsule or berry, dry and flat in the former case, three-angled, three-celled, either indehiscent and one-celled, when baccate, or three-valved, and loculicidal. The seeds are winged, flattened, or round. The endosperm is hard, dense, horny, and quite surrounds the small embryo.

The Yam (*Dioscorea*) forms an article of food, being poisonous and acrid, but edible when boiled, and as a cultivated plant yielding a white and mealy variety, others being yellow, watery, and bitter. The berries of Black Bryony are poisonous. The tubers of another plant of the genus *Testudinaria* are also used as articles of food; the Hottentot Bread, *T. elephantipes*, being cultivated as a greenhouse plant. Willis describes it thus: "It has the general habit of a Dioscorea, but has an enormous tuber projecting out of the soil, with a thick outer coating of cork. This tuber is the swollen first internode of the stem. From it yearly, during the wet season, there springs by

adventitious budding the year's shoot—a long, thin, climbing stem, with large leaves and small flowers. This dies down in the dry season and the corky covering protects the mass of the plant from drought."

## CORONARIEÆ.

In this series are included the Lily group, the Rush group, and the Pipewort group.

The perianth is in two whorls, and is petaloid as a rule. The ovary is superior and syncarpous. The seeds possess endosperm.

Here are included some of the most lovely flowers in the world, of the Order Liliaceæ, such as the Lily-of-the-Valley, Tulip, Scilla, etc. In the Lily-of-the-Valley and Rush groups the flowers are hermaphrodite. In the Pipewort group the plant is monœcious. The perianth is six-partite, petaloid in the Lily-of-the-Valley group. There are six stamens in the Lily-of-the-Valley and Rush groups, two to three in the Pipewort group. The ovary is one- to three-celled.

The fruit is a capsule, berry, etc. The flowers are conspicuous in Liliaceæ and adapted to insects. In the Rush group they are wind-pollinated. The plants are herbaceous, except Butcher's Broom, which is a shrub. The Liliaceæ are large bulbous plants. The Rush group consists of marsh plants; like the Pipewort group some are aquatic.

## 80. The Lily-of-the-Valley Group.

This is one of the most extensive groups in the plant realm. There are some two thousand five hundred species, and two hundred genera. In this Volume are described, as British types, Butcher's Broom, Lily-of-the-Valley, Simethis, Crow Garlic, Bluebell, Fritillary, Bog Asphodel, and Herb Paris. These respectively illustrate the ten tribes into which the Order Liliaceæ has been divided by Hooker. This arrangement includes the Order Melanthaceæ or Meadow Saffron Group, which was described in the Introductory Volume, p. 206.

Including so many species it is natural that the group, as a whole, is cosmopolitan, but certain types are characteristic of definite floral regions.

From the Juncaceæ to which the group is closely allied the Lily-of-the-Valley group differs in the petaloid perianth, which is sepaloid in the former. A few Liliaceæ, however, have a sepaloid perianth. A further distinction lies in the thread-like stigmas of the Rush group, which is adapted to wind-pollination.

The rhizomes are sympodial, and many of these plants possess bulbs. Most of the Liliaceæ are herbaceous and many are geophytes. There are a few shrubs as Butcher's Broom, which possesses phylloclades, and trees as Yucca, Dracæna. They frequently exhibit, in the case of the Tropical types,

adaptations to resist drought. Smilax and Gloriosa are climbing plants.

The root is fibrous. The rootstock may be bulbous, creeping, clustered. The leaves are radical, with scapes, or there may be leafy flowering stems as in Asparagus.

The inflorescence is usually racemose. There are usually no bracteoles. If they are present the inflorescence may be cymose in part, forming a bostryx. In some types, as in the Garlic, the cyme takes the form of an apparent umbel. Several types such as Fritillaria possess solitary terminal flowers. The flowers are complete, rarely unisexual. They are regular, pentacyclic, the parts in threes (or two, four, or five), and hypogynous. The perianth is inferior, six-partite, in two whorls of three, free or united, petaloid or sometimes sepaloid, overlapping or valvate in bud. The stamens are usually six, but in *Ruscus* there are only three. They are hypogynous or inserted on the perianth. The anther-stalks vary in length, and are long or short. The anthers open inwards, and are oblong or linear. The ovary is three-celled, free, usually superior, but sometimes inferior or half-inferior. When three-locular the placentæ are axile, when one-locular parietal. There are one or three styles, or the stigma may be sessile. The latter is simple or three-lobed. There are three ovules or many, in two rows in each cell, anatropous. The fruit is a capsule or berry (Asparagus, etc.), three- or one- to two-celled. The seeds are one or

more in each cell, with horny or fleshy endosperm. The embryo is small, straight or curved.

Some flowers have honey, others pollen only. There are sham nectaries in Herb Paris. The flowers, being attractive, are usually pollinated by insects. Many possess a delicious scent as Lily-of-the-Valley.

In the case of the capsular fruits, the fruits are usually partly wind-dispersed, the berries dispersed by birds, etc.

So large a group contains naturally many notable types. In particular a large proportion of our garden plants of surpassing beauty, such as the Hyacinth, Tulip, etc., is drawn from the Lily-of-the-Valley group. Some, as the Onion, Garlic, Asparagus, are vegetables. Fibres are yielded by the New Zealand Flax and other plants. Some plants, such as the Aloe, Meadow Saffron, are employed in medicine. Resins are derived from *Xanthorrhea* and *Dracæna*.

### BUTCHER'S BROOM (*Ruscus aculeatus*).

From the habit of growth this plant is called Butcher's Broom. It is indeed the only British type which has the shrub habit, and it is not bulbous like the majority of the Lily-of-the-Valley group. It is moreover also an evergreen. The name Ruscus was given by Virgil. In shops in Gerard's time it was termed Bruscus. The second Latin name refers to the prickly leaves or phylloclades.

This is an interesting example of a plant in which the leaves are replaced by flattened branches or

cladodes, twisted below, so that the lower surface is uppermost. These phylloclades are placed in the axils of scaly leaves. There is another scaly leaf half-way up, which bears solitary flowers in its axils.

Being more or less a chalk plant, Butcher's Broom is mainly confined to the South of England, being abundant in the Isle of Wight area. It occurs south of Norfolk, Leicester (if it can be regarded as anything but a naturalised plant there and elsewhere so far north) and South Wales. In the North of England, in Scotland, and Ireland it is undoubtedly merely naturalised. It occurs as a native species in the Channel Islands.

Woods and copses form the native habitat of the plant. It occurs on chalk in Beechwoods, and in chalk scrub.

A shrub, Butcher's Broom is erect, much branched, rigid, dark green. The stems are tufted, stout, woody, angular, the young shoots scaly. The numerous cladodes are ovate, with a narrow prickly point, acute, rigid, twisted below.

Borne on scaly leaves on the cladodes, the flowers are apparently stalkless, the stalk being attached to the lower (or actual upper) surface. They are solitary, rarely two, white, with a minute, membranous, one-veined bracteole below, in the axil of which the flower is borne. The male flowers are borne on narrower cladodes. The perianth is six-partite. There are three stamens. The berry is bright red or yellow.

C. Mosley. FIG. 86.—BUTCHER'S BROOM (*Ruscus aculeatus*). *See page* 319.

FIG. 87.—LILY-OF-THE-VALLEY (*Convallaria majalis*).
*Messrs. Flatters and Garnett* (Copyright). *See page* 322.

The plant is 1 to 2 ft. in height. It flowers in March and April, and is an evergreen perennial shrub.

The anther-stalks unite to form a tube. The plant is diœcious, or frequently so, or monœcious. In either case pollination must be effected by outside agency, *i. e.* insects. As fruit is frequently to be found cross-pollination must generally result.

Birds disperse the berries, which are scarlet or yellow, and attract attention.

Britten and Holland cite the following names, Prickly Box, Box Holly, Butcher's Broom, Jew's Myrtle, Knee Holly, Knee Holme, Knee Hulver, Kneehul, Wild Myrtle, Petigree, Shepherd's Myrtle.

Authorities differ as to why this plant is called Butcher's Broom. One author says that it is "because butchers used to make brooms of it to sweep their blocks." But in Germany and Italy the reason given is, "because of its use to preserve meat, by covering it, from mice and rats." In fact the Italian name is Pongitopo, or prickmouse.

This is the plant which is dyed a pink colour and sold in greengrocer's shops for decoration. It has also been used for wreaths for graves. The young shoots have been eaten like asparagus in Greece. The red berries have been roasted and used in place of coffee in Corsica. London cigar manufacturers have used the boughs to sprinkle a saline liquor over tobacco leaves. The plant is much used for ornamental plantation in shrubberies.

RUSCUS ACULEATUS.—*In Fig.* 86 *the shrub-like*

*character is shown; the ovate cladodes, with their prickly points, are also well-shown.*

LILY-OF-THE-VALLEY (*Convallaria majalis*).

Because it was supposed to grow in valleys the plant was so-named in English, and the Latin name is intended to refer to the same notion. The second Latin name means belonging to May. May was, in Greek mythology, dedicated to Maia, who was the daughter of Atlas and the mother of Mercury.

Though nowhere really abundant the Lily-of-the-Valley is found in many counties in England. It is not indigenous in Scotland or Ireland. In the north of England it ascends to 1000 ft.

Woods, thickets, or shaded places are the habitat of the Lily-of-the-Valley. It is found on sandy soil in the sandy dry oakwood, on limestone in ashwoods, and in limestone scrub.

Its shade-loving habitats are versed by Wordsworth in "The Excursion":

> "And leaves of that shy plant,
> (Her flowers were shed) the lily of the vale,
> That loves the ground, and from the sun withholds
> Her pensive beauty, from the breeze her sweets."

Creeping in habit below, from a slender root-stock the aerial stem is a scape and the leaves radical. The roots are fibrous. The plant propagates itself freely by its spreading rhizomes. The leaves are usually two together, enveloped below in a scaly sheath, ovate to lance-shaped, with a long, slender,

sheathing stalk, and the stalks are enclosed in each other so that this gives the plant the appearance of having a stem. The blade, which is oblong, is tapered at each extremity.

The scape is leafless, semi-cylindrical, angular, radical, not so long as the leaves. The flowers are drooping, bell-shaped, pure white. Shelley recalls their form and beauty in " The Sensitive Plant ":

> " And the Naiad, lily of the vale,
> Whom youth makes so fair and passion so pale,
> That the light of its tremulous bells is seen,
> Through their pavilions of tender green."

The flowers are sweet scented, and as Thompson in " The Seasons—Spring " writes:

> " Where scattered wild the Lily of the Vale
> Its balmy essence breathes."

The flowers are in a loose raceme, six to twelve, on curved flower-stalks. Rarely they are rose-coloured. In form they are nearly round. The perianth-segments have the tips free and are bent back. The bracts are membranous. The globular berries are red.

Usually the Lily-of-the-Valley is 6 in. high, but it varies from 4 to 9 in. It is in bloom in May and June, and is a herbaceous perennial.

Though there is no free honey, the tissues contain a sweet sap. The flowers are visited by insects, however, for pollen. Their pendulous position protects the pollen from rain or drops from the overhanging boughs of trees. The anthers may ripen in advance

of the stigmas, or at the same time. As the stigma exceeds the stamens in length insects will touch it first, and thus cross-pollination is ensured. But self-pollination is possible, as in other pendulous flowers, in the absence of insect visitors. The sweet scent of the flowers, in spite of the plant being a shade-lover, adds to the chances of insect-pollination.

Being attractive and conspicuous the scarlet berries are dispersed by birds.

Several common names are enumerated in the 'Dictionary of English Plant Names,' as Conval Lily, Great Lily, Park Lily, May Lily, Wood Lily, Lily-among-thorns, Lily-conval, Liricon Fancy, May Blossoms, Mugwet, Valleys.

Lady chapels in the past were decorated with the Lily-of-the-Valley amongst other flowers, each in their season. Several names above denote its special season of flowering. It must not be confounded with the other May Lily, *Maianthemum Convallaria*, a much rarer plant.

As to its uses Gerard says: "Flowers of Lily-of-the-Valley being close stopped up in a glass, put into an ant-hill, and taken away again a month after, ye shall find a liquor in the glass, which being outwardly applied helpeth the gout."

In flower language it denoted the return of happiness and unconscious sweetness, being a May flower, flowering in May, with its bright sun and wealth of bird song and flowers. In Hesse a toll of May flowers was required every year for rent. The Lily-

of-the-Valley among thorns was one of the emblems of the Virgin Mary. There is a superstition that it is unlucky to transplant a bed of Lilies-of-the-Valley, and in Devonshire it is also unlucky to plant a bed, as the person who does will probably die in the ensuing year.

CONVALLARIA MAJALIS.—*The illustration (Fig. 87) shows the habit of the plant, with its two alternate leaves and sheathing stalks, and the loose raceme with drooping flowers.*

### SIMETHIS (*Simethis bicolor*).

There was a Sicilian nymph of the name of Symethis from which this plant is named. The second Latin name refers to the two colours of the flower.

Extremely rare in England, and practically extinct in Dorset, the last plants being removed to a safe place for preservation, Simethis also grows in Ireland. Its nativity has been questioned, for it has been supposed to have been introduced from the West of Europe with seeds of Pinus Pinaster, which grows at Bournemouth.

Fir woods, open sandy heath and wastes or rocky places are the habitats of this rare plant.

There is a short rootstock and the roots are tufted, stout, thick, fleshy, and fibrous. The leaves are radical, linear, long, grass-like, bent back, flat, or keeled above, sheathing, brown, flat, concave. Scales enclose the stem (or scape) and leaves, which latter are surrounded by torn fleshy fibres.

The scape is forked, with a bract below each branch, the lowest bracts linear, leaflike, and as long as the leaves. The flowers are erect, in a loose, terminal corymb. They are purple outside, white within (hence *bicolor*). The perianth is spreading, with six oblong segments, which are blunt and hollow. The stamens are included, not so long as the perianth-segments, and inserted near the base. The anther-stalks are woolly. The style is simple. The fruit is a capsule, bluntly angled, three-valved, and there are two shining, black seeds, with thick white stalks.

From 6 to 18 in. high, Simethis flowers in May and June, and is a herbaceous perennial.

Being variegated and having a more or less conspicuous appearance, several flowers being aggregated into each corymb, the flowers are likely to be visited by insects. Many Liliaceæ have drooping flowers. In Simethis they are erect, and the anther-stalks are woolly, a provision often made in honey flowers adapted to insects.

When produced the seeds which are small may be dispersed by the wind.

The only name by which this flower is known is Variegated Simethis or simply Simethis.

SIMETHIS BICOLOR.—*Note in Fig.* 88 *the tufted roots, the long, linear, grass-like leaves, with scales below, and the terminal corymb, borne on a forked scape with bracts below each fork. The six stamens are placed above the six petals.*


*H. G. Herring.* FIG. 88.—SIMETHIS (*Simethis bicolor*). *See page* 325.

### Crow Garlic (*Allium vineale*).

This plant is one of the Garlics for which the generic name given by Plautus was the first Latin name. The second Latin name denotes pertaining to vineyards. The plant would more appropriately be called Vineyard Garlic on the Continent, where vineyards are in some districts extensive.

Crow Garlic is not a common plant in the British Isles, but rather what we should term local, being found here and there only in England and Wales, Scotland, Ireland, and the Channel Islands.

Waste dry places, fields and pastures, form the habitat of the Crow Garlic. It is found on sandy soil on dry grass heath. On limestone soil it is also found on limestone grassland.

There is no mistaking the habit of the narrow-leaved forms of Garlic which have a grass or rush habit. There is only a small bulb. The aerial stems are scapes, and, as in similar cases, the leaves are radical. They are hollow, flattened or grooved above, round in section, with long, slender points. They are about 2 ft. long.

The flowers are in an umbel, on a long cylindrical scape. There is a one-valved, solitary, short spathe, with a long slender point. When the plant is in flower the leaves wither. The flowers are few, rose-coloured, with green keels, on long stalks. The flower-stalks are slender, thickened above. With the flowers are bulbils or there may be only bulbils.

The bulbils are green or purplish. The three-pointed anther-stalks are projecting. There is an antheriferous point to the anther-stalks which equals the entire portion. This is half as long as the lateral points.

Crow Garlic is 1 to 3 ft. high, flowering from June to August, and is a herbaceous perennial.

The spathe with its bracts serves to conceal the honey. There are six stamens, which are longer than the stigmas, and they are in two rows of three each. Since the flowers are more or less conspicuous, they are likely to be cross-pollinated, flowering at a time and in a place where insects are usually abundant.

Being reproduced largely by the bulbils which are liable to be eaten by birds (hence Crow Garlic), this plant is dispersed by animal agency.

There are less than half a dozen common names for this plant, Cow Garlick, Crow Garlick, Wild Garlick, Crow Onion.

Garlic is derived from the Anglo Saxon *gar*, spear, and *leac*, leek.

The plant is used for flavouring salads, like Chives.

ALLIUM VINEALE.—*Note in Fig.* 89 *the grass-like habit and the terminal flower-head.*

### BLUEBELL (*Scilla nutans*).

Called also Wild Hyacinth, this lovely wild flower is more nearly related to the garden Squills, since the perianth-segments are more or less distinct. The beautiful colour of the flowers and their drooping

*W. E. Mayes.* FIG. 89.—GARLIC (*Allium vineale*). *See page* 327.

FIG. 90.—BLUE BELL (*Scilla nutans*). A BLUE-BELL WOOD IN SPRING.
*W. Bell.* *See page* 328.

habit is recalled in the English name (and the second feature in the Latin specific name). Who can fail to be moved by the eloquent beauty of a wood carpetted with a sheet of Bluebells in early spring? Such loveliness on so grand a scale must impress the smallest soul. The Bluebell of Scotland is the Harebell, which is equally beautiful.

There are few districts in the British Isles where Bluebells do not grow. But they are less widespread and abundant than formerly owing to the devastation wrought, in the main by the hawker, upon them. They are to be met with from the extreme north of Scotland to Cornwall, and in Ireland, and the Channel Islands. In the Lake District they grow at 1500 ft. or more.

Woodlands are the favourite habitat of the Bluebell, but they are to be met with on open hillsides, heaths, in hedgebanks, and by the wayside. Bluebells grow on clays and loams in damp oakwoods, on sandy soil in dry sandy oakwoods. They are found in the Oak-Birch heath association, on siliceous soils in sessile oakwoods, and with bracken on siliceous grassland.

Like other bulbous plants the Bluebell has a rosette of radical leaves and an erect leafless scape or flowering stem. The bulb is white and contains a sticky juice. The leaves are broad, linear, more or less acute, hollowed.

The scape is solitary, tall, stout, angular. The flowers are deep blue, in a terminal, drooping raceme, one-sided. The flowers also are drooping. There is

a small bract at the base of each ultimate flower-stalk. These last are curved, but erect in bud and in fruit, the bracts being paired, linear, membranous. The perianth is bell-shaped, or tubular, the segments spreading at the ends, distinct or shortly united below. The stamens are attached to the perianth-segments below the middle, but some way above the base. The capsule is nearly round, three-angled.

From 6 to 18 in. is the height of the Bluebell, which flowers in April and May, being a herbaceous perennial.

Honey is secreted by glands in the septa of the ovary, being more or less free. The pendulous position of the flower ensures that it will be protected from the rain. The flowers are sweet-scented and growing in wide patches are conspicuous, as they are indeed individually. Numerous insect visitors may be watched at the flowers, and cross-pollination is the natural sequence.

After the capsule, which is three-valved, is ripe and opens, the seeds, which are numerous, are dispersed by the wind.

Being so popular a plant it is natural that there are many English names, which, following Britten and Holland, are: Bell-bottle, Hare Bell, Wood Bells, Bloody Man's Fingers, Blue Bell, Blue Bottle, Blue Gramfer Greygles, Blue Rocket, Crake-feet, Craw-feet, Craw-flower, Craw-taes, Craw-tees, Cross-flower, Crow-bells, Crow-flower, Crowfoot, Crowleek, Craw-toes, Cuckoo, Cuckoo-flower, Cuckoo's Stock-

ings, Culverkeys, Culvers, Gowk's-hose, Gramfer-greygles, Gramfer-gregors, Snap Grass, Greygle, Guckoos, Hyacinth, Crow Leek, Ring o' Bells, Blue Rocket.

The Bluebell was worn on St. George's Day, April 23rd, the flower being dedicated to St. George.

> "On St. George's Day when blue is worn,
> The blue Harebells the fields adorn."

The date here determines which Harebell is meant. The colour of Bluebells was regarded as an emblem of the blue seas over which England holds its sway.

The poets call it the Hyacinth.

Thus Shelley writes:

> "And the Hyacinth, purple, and white, and blue,
> Which flung from its bells a sweet peal anew
> Of music so delicate, soft, and intense,
> It was felt like an odour within the sense."

So too Lucy Hooper:

> "By field and by fell, and by mountain gorge,
> Shone Hyacinths blue and clear."

And an old poet, George Croly:

> "Come, evening gale, the crimsonne rose
> Is drooping for thy sighe of dew.
> The hyacinth wooes thy kisse to close
> In slumbers sweete its eye of blue."

SCILLA NUTANS.—*The illustration* (*Fig.* 90) *gives an excellent idea of the habitat of the Bluebell and its social habit. The wood depicted is a mass of blue colour in early spring.*

Snake's Head Fritillary (*Fritillaria meleagris*).

For a wild flower, and the plant is a true native, this is assuredly a gem amongst many. Owing to the peculiar shape of the flower, the first Latin name, which means a dice-box, was bestowed by Lobel. The second name is an old first name applied by Dodonæus and means a guinea-fowl. This refers to the markings on the flower. The name Snake's Head refers to the peculiar shape, also like a snake's head, as well, perhaps, to the chequered markings like a snake's scales.

There is no doubt that in some parts of the country the Fritillary is not wild, but an escape from cultivation, but in some of the south and east counties of England, it appears to be native. In Scotland and Ireland it is, however, not apparently indigenous.

Moist meadows and pastures in the Thames Valley and East Anglia are the habitat of the Fritillary. It is thus a member of the marsh formation or tracts that have been once marsh.

In habit the Fritillary is like other plants more or less lily-like. There is a small bulb with two to three swollen scales. The leaves are alternate, linear, or lance-shaped, flat, more or less acute.

The scape bears a single flower which is terminal, drooping. In colour the flowers are dull red, or purple, with chequered light and dark markings, lines, and spots. Occasionally white flowers are to be found. There are a few short leaves on the scape.

FIG. 91.—SNAKE'S HEAD FRITILLARY (*Fritillaria meleagris*).
*Messrs. Flatters and Garnett* (Copyright). *See page* 332.

FIG. 92.—SNAKE'S HEAD FRITILLARY (*Fritillaria meleagris*).
*Messrs. Flatters and Garnett* (Copyright). *See page* 332.

The perianth-segments are oblong, narrow at each end, the inner having oblong or linear cavities. The anthers are yellow. The capsule is erect, three-angled, three-valved above. The seeds are numerous, close, flattened or winged.

The Fritillary is 6 to 15 in. high. It flowers in April and May and June, and is a herbaceous perennial.

The size of the flowers makes them attractive. The markings render them more conspicuous. The stigma is ripe in advance of the stamens. The honey-gland is narrow. Honey is secreted by the perianth-segments. The drooping of the flower helps to protect it from rain. The flowers last about five days. There is every possibility of cross-pollination.

The seeds are dispersed by the agency of the wind, being, as in orchids, small and light.

There are many names for this plant, as Dead Man's Bells, Chequered Daffodil, Chequered Lily or Tulip, Cowslip, Crow-cup, Daffodil, Deith-bell, Drooping Tulip, Frits, Froccup, Guinea-hen Flower, Lazarus Bell, Chequered Lily, Leopard's Lily, Pheasant Lily, Snake Flower, Snake's Head, Snow-drop, Toad's-heads, Wild Tulip, Turkey Eggs, Turkey-hen flower, Turk's Head, Weeping Willow, Widow Wail.

Lazarus Bell was originally Lazar's Bell, the plant being said to be so called from the resemblance of the flower to the bell worn by a lazar; and the chequered flower was the origin of the name Leopard Lily, or Leper's Lily.

FRITILLARIA MELEAGRIS.—*In Fig. 92 the flower is*

*shown expanded, but still drooping, and in Fig.* 91 *unopen with its snake-like form. Note the chequering of the colour of the flower.*

BOG ASPHODEL (*Narthecium Ossifragum*).

In the first Latin name, derived from the Greek for a rod, the long straight raceme of the Bog Asphodel is indicated. Originally the name was applied to another plant from which Asafœtida is obtained. The second name means "breaking bones," the reason for the application of which is hardly clear, though it was said that it was applied from causing softening of the bones of cattle, but this is due if anything to the wet habitat or bog in which the plant grows.

Bog Asphodel is found in all parts of the British Isles, but, like other bog plants, chiefly in Scotland and west England, the Lake District, and where the rainfall is high. It is not uncommon in Ireland.

As the English name implies the habitat of the Bog Asphodel is bogs, where the soil is turfy or peaty, wet moors, and other damp spots.

Being adapted to drought of a physiological type, owing to the cold soil, which lessens the rate of absorption, the plant has reduced leaves, which have a symmetrical internal structure, stomata both sides, and with the edges turned to the light, or isobilateral. The rhizome is sympodial, shortly creeping, rooting below, prostrate, wiry, long, and slender. The leaves are radical, grasslike, rigid, strongly ribbed, with a long narrow point, not so long as the stem,

FIG. 93.—BOG ASPHODEL (*Narthecium Ossifragum*).
*Messrs. Flatters and Garnett* (Copyright). *See page* 334.

FIG. 94.—HERB PARIS (*Paris quadrifolia*).
*Messrs. Flatters and Garnett* (Copyright) *See page* 336.

which is stiff and erect. The leaves are linear below, flattened vertically, sheathed below, and in two rows. The upper are reduced to short scales.

Bright-yellow in colour, and in a stiff, terminal raceme, the flowers are large, the scape having a few, clasping, short leaves. The perianth-segments are nearly equal, spreading, sword-shaped, lance-shaped, linear to oblong, pointed, green on the back, longer than the stamens, not so long as the capsule, persistent. There is a single awl-like bracteole at the base of the ultimate flower-stalks, and a second above the middle. The anther-stalks are white and woolly. The anthers are deep orange. The capsule is smooth, red or dark yellow, and pointed, oblong, triangular, narrow, with six longitudinal furrows. The seeds have an awl-like point at each end, and are pale yellow.

The Bog Asphodel is 6 to 12 in. high. It flowers in July and August, and is a herbaceous perennial.

There is a similarity between the stamens of the Bog Asphodel and those of Simethis, the anther-stalks being bearded. The style is simple as in the latter. The flowers are scented like those of *Habenaria bifolia*. There is no honey. The anthers and stigma ripen simultaneously. The flowers are pollen flowers. But insects also visit them for the sweet sap in the tissues.

Being three-valved below the capsule allows the seeds to fall out near the plant or to be blown away by the wind.

The Bog Asphodel is also called Bastard Asphodel, Lancashire Asphodel, Yellow Grass, Knavery, Maiden-hair, Moor-grass, Rosa-solis.

As to the last name Ellis writes: "This moor-grass in the Parish of Wing, they call Rosa-solis, as it is distinguished by shepherds from other grasses, who know it by its three-square leaf, rapier-like, for its blade, like that, is thickish, and shaped somewhat in the flag kind, bearing a yellowish flower, like that of a Daff-a-down-dilly, and seldom runs above a handful high, in a spungy soft substance."

Lobel says the plant was formerly called Maiden-hair because girls used it to dye their hair yellow, a fashion prevalent in the Middle Ages.

NARTHECIUM OSSIFRAGUM.—*The illustration (Fig. 93) exhibits well the habit of the plant, the rhizome forming a sympodium, the grass-like leaves, and the terminal raceme of flowers.*

### HERB PARIS (*Paris quadrifolia*).

There is no connection between the mythical Paris and this plant, the word being derived from *par*, equal, on account of the regularity of the leaves and flowers, but this is not always so. The second Latin name refers to the number of leaves, four as a rule, but there may be five or more.

Found in most parts of the British Isles Herb Paris is rather local. It does not grow in Ireland.

Woods almost entirely, or shady places, are the

habitat of the plant, which grows on clay and loam in the damp oakwood, and on marls and calcareous sandstones in ash oakwoods, on chalk in beechwoods.

The habit is erect. The stem is round in section, with leaves in a whorl at the top, with a basal sheath. The leaves are four or more (three to eight), broadly ovate, or inversely ovate, oblong, acute, three- to five-nerved.

The flower is solitary, pale green, erect, stalked. The stalks are 1 to 2 in. above the leaves. The perianth is yellowish-green. The four outer segments are narrow to lance-shaped, the four inner linear, more yellow. The anthers are linear. The anther-stalks are slender. The connective is produced. There are four styles. The berry is four-celled, black, or bluish-black, and opens irregularly. The seeds are black, with a leathery testa. There are four to eight seeds in each cell.

In height Herb Paris varies from 6 in. to 1 ft. It is in flower from May to July, and is a herbaceous perennial.

When the leaves are in fours the parts of the flower are in fours. There are five parts to the flower if there are five leaves. The perianth-segments are five or ten respectively. There are as many stamens, which are more or less hypogynous. The flowers contain no honey, and are strong-smelling. The stigma is ripe in advance of the stamens. The ovary is a dull red colour, to which flies are attracted. It has the appearance of decaying meat. There may

be no stamens in some flowers. The flowers are long-lived.

The fruit is a berry and dispersed by birds, being indehiscent.

The names given to Herb Paris are, Devil-in-a-bush, Four-leaved Grass, Herb Truelove, Leopard's Bane, One-berry, Trewe-lufe, True-love. In Sweden it is called Puck's Berry. The name Devil-in-a-bush, by which it is known in Perthshire, is applied because the flower is surrounded by four leaves. The name Truelove is from the Danish *Trolove,* to betroth or affiance, referring to an old custom of making a knot as an emblem of plighted fidelity. The leaves have a resemblance to a true-love knot.

PARIS QUADRIFOLIA.—*In Fig.* 94 *one of the plants shows five leaves, the other four. The outer perianth-segments are well shown.*

## 81. THE RUSH GROUP (SUMMARY).

(*Introductory Volume, p. 212.*)

This is a fairly extensive Order (Juncaceæ) containing about 200 species and seven genera. They are natives of Temperate and cold regions, and the Arctic regions. They are allied to the Liliaceæ, differing in the perianth, and have the habit and characteristics of Sedges and Grasses.

Their habit is characteristic and uniform. Most are tufted and erect, a few being prostrate and rooting at the nodes.

The members of this group are all herbaceous. Only a few are annuals, the rest perennial. There is a creeping, sympodial rhizome, as in Liliaceæ. Each year one joint of the sympodium appears above the ground as a leafy shoot. The stem is not lengthened, except the part bearing the inflorescence. The rootstock bears scales. The stems are erect, simple as a rule, and in some cases have internal septa, with continuous or interrupted thick, white pith. The leaves are narrow, often, as in Rushes, centric. They are slender, narrow, flat, or round in section, cylindrical, or are merely sheathing scales, and stiff.

The inflorescence is a crowded cyme, usually monochasial. The flowers are small, green or brown, axillary or terminal, or apparently lateral, regular, bisexual, with bracteoles. The perianth is regular, dry, inferior, sepaloid, in two whorls, three- to six-partite, with the odd segment of the inner whorl posterior. It is membranous or leathery. The segments are distinct, persistent, nearly equal, overlapping in bud. There are six stamens in two whorls of three, or without an inner whorl, inserted at the base of the segments. The anther-stalks are flattened. The anthers open laterally or inwards, and are usually linear, basifixed. The pollen is in tetrads. The ovary is free, one- to three-celled, superior, of three carpels. The placentæ are axile or parietal. The styles are short or wanting, simple. There are three slender stigmas, which are brush-like, papillose

all over. There are three ovules or many, anatropous, erect. The capsule is one- to three-celled, loculicidally three-valved, three- or many-seeded. The seeds are erect, with a membranous testa. The endosperm is dense and starchy. The embryo is straight.

The flowers are wind-pollinated. The seeds are wind-dispersed.

There are no plants of economic importance. The Rushes may serve to convert wet spongy land into dry stable land. Along the coast maritime species serve to protect the shore from coast erosion.

### Great Wood Rush (*Luzula sylvatica*).

By Smith the Wood Rushes were included in a genus *Luciola*, which he considered more correct, etymologically, than *Luzula*. He remarked: "The hairy heads of flowers, wet with dew, and sparkling by moonlight, gave the elegant Italians an idea of their luciola, or glow-worms, sometimes written luzziola, but this is a provincial corruption. Hence, however, John Bauhin got the name of *gramen luzulæ*, or glow-worm grass, for he never called it *Luzula*, which would have been the same as actually calling it glow-worm." A more recently adopted generic name is *Juncoides* of Adanson, which has precedence.

This Woodrush is found in all parts of the British Isles as far north as the Shetlands. In the Highlands it is found at an altitude of 2300 ft., or more. It occurs in Ireland and the Channel Islands.

FIG. 95.—GREAT WOOD RUSH (*Luzula sylvatica*).
*Messrs. Flatters and Garnett* (Copyright). *See page* 340.

*The Author.* FIG. 96.—PIPEWORT (*Eriocaulon septangulare*). *See page* 344.

As the specific name implies it is a woodland plant, found in woods and on heaths, and on sandy places, chiefly in hilly regions. It occurs on clay and loam, in damp oakwoods, on sandy soil in dry sandy oakwoods, and on siliceous soils in sessile oakwoods.

Like other Woodrushes the habit is tufted. It is the largest and tallest British species. The rootstock is woody, short, with short stolons. The stems are few. The leaves are broad, shining, finely-furrowed, with few silky hairs, hairy at the edge, channelled, linear to lance-shaped. The stem-leaves are few and short.

The flowers are in large, loose, doubly compound cymes, clustered (three flowers), exceeding the leaflike bracts. The branches are spreading in fruit. The perianth-segments are bristle-pointed, not as long as the capsule. The flower-stalks are three-fid, long. The bracteoles are ovate, acute, with a membranous border. The anther-stalks are very short. The capsule is ovoid, ovate, acute, beaked, blunt-pointed. The seeds are tubercled at the end, without appendages.

In height this Woodrush is 1 to 2 ft. It flowers from May to July, and is a herbaceous perennial.

As in other Woodrushes the flowers are wind-pollinated. The stigma ripens before the anthers, which are longer than their stalks. The female flowers are in bloom from one to two days. The anthers open whilst the stigmas are still receptive, and self- as well as cross-pollination may result.

The capsule is three-valved, and when ripe the

seeds are scattered near the plant, or to a distance if the stems are agitated by the wind.

Wood grass, Shadow-grass, Wood-blades, are names for this plant.

LUZULA SYLVATICA.—*Fig.* 95 *gives a good idea of the tufted habit of the plant, the broad leaves, the large, loosely-clustered cymes, the branches spreading in fruit.*

## 82. THE PIPEWORT GROUP.

The Pipeworts are South American plants, and the species found in the British Isles is a recent introduction, unless we regard it as a relic of a more extensive American flora, existing in this area, which was continuous with that of America itself, there being a land-bridge between the Old and New World in comparatively recent times, as is believed by good authorities such as Dr. Scharff.

Of the Order Eriocaulonaceæ there are some 340 species and six genera. They are mainly Sub-tropical and Tropical in distribution. They are especially numerous in America up to the Arctic Circle, and are found in Asia, Africa, and Australia. Except in the British Isles the species described is not known in Europe, or in Russian Asia.

The affinities of the group are with the Restiaceæ and Xyridaceæ.

The majority of these plants are perennial and herbaceous. They are aquatic and marsh plants. The habit is the rosette habit as a rule, with radical

leaves and aerial stems in the form of scapes. The leaves are cellular, narrow, grass-like.

The inflorescence forms a head with an involucre, bearing bracts. The flowers are unisexual, small, with the parts in twos or threes, regular or irregular. The plants are usually monœcious.

The perianth is generally sepaloid, membranous, or with a membranous border, two- to six-partite, or in two whorls. The male flowers have two to three free outer segments, and the inner are united into a two- to three-lobed tube, with four or six stamens (or three or two) inserted on the tube opposite the segments, or with some alternate imperfect ones. The anthers are dithecous or monothecous, and fixed by the back, opening inwards. The anther-stalks are turned inwards in bud. There may be a rudimentary ovary. The female flower has an inferior perianth, and a superior ovary of two to three carpels united at the base. The outer segments are as in the male flowers, and in the inner there are two to three segments, or they are reduced to a pencil of hairs. There are no staminodes. The style is short, terminal, persistent. There are two to three slender stigmas. The ovules are solitary, pendulous, and orthotropous. The capsule is membranous, two- to three-celled, and two- to three-valved, loculicidal. The seed is pendulous, with a leathery testa. The epidermis is transparent and splits up into hairs. The endosperm is floury. The embryo is lens-shaped, outside and at the base of the endosperm,

furthest from the hilum. In Luzula the ovules and seeds are erect from the base, not pendulous.

There are no economic properties of importance belonging to the plants of this order.

### Jointed Pipewort (*Eriocaulon septangulare*).

Since the first species which was placed in the genus had a woolly stem, or scape, the generic name was appropriate, but in most of the species it is smooth. The furrows on the stem suggested the specific name for this species.

An American plant, the Pipewort is found in two regions in the British Isles, one in Scotland, the Outer Hebrides, Skye, Coll. It also occurs in the west of Ireland in the Connemara district. It is not found elsewhere in Europe. There are three other Irish-American plants, *Sisyrinchium angustifolium*, Blue-Eyed Grass, and *S. californicum*, and *Spiranthes Romanzoffiana*, Irish Ladies' Tresses.

The habitat is shallow lakes. The plant occurs in the fresh-water aquatic formation in waters relatively poor in mineral salts in the submerged-leaf association.

Tufted in habit the plant has a slender rootstock, which creeps in the mud, with white, jointed fibres, cellular. The stems or scapes depend on the depth of the water for length. The leaves are in tufts, linear, awl-like, green, with a soft point, transparent, flattened from side to side, smooth, septate.

The flowers are in heads, on a long scape, which is twisted, six- to eight-furrowed, longer than the leaves, with a long sheath at the base. The flowers are numerous, white. The bracts are lead-coloured (as are the perianth-segments), broad, oblong to inversely ovate, and blunt, forming an involucre. The male flowers are in the centre, with four stamens. The fertile flowers are four-partite, divided nearly to the base. The two lateral divisions are keeled, flattened, blunt, fringed and black. The outer perianth-segments are dark, with chaffy hairs. The inner segments are fringed with hairs with a black spot at the tip. The anthers are dark. The ovary is two-lobed, stalked. There are two stigmas, with a single style. The capsule is two- to three-celled.

In height the Pipewort varies from 4 in. to 2 ft. It is in flower from July to August, and is a herbaceous perennial.

Since the plant is monœcious the flowers must be cross-pollinated by outside agency, the male flowers being more or less central, as the anthers open inwards, and are bent in bud.

The fruit, a capsule, opens by valves, and the seeds may be wind-dispersed and then water-dispersed, the tuft of hairs serving to prevent the seeds from being wetted or from sinking.

Pipewort, or Jointed Eriocaulon, are the only names for the plant, which is rare and little-known except to the botanist or specialist.

ERIOCAULON SEPTANGULARE.—*In Fig.* 96 *note the tufted rosette habit, radical leaves, and long scape, with flowers in a terminal head.*

### NUDIFLORÆ.

In this group the perianth is either rudimentary or absent. The ovary is superior, syncarpous or monocarpellary.

It includes the Reed Mace group, Cuckoo Pint group, and Duckweed group.

In the first the plant is monœcious, in the second the flowers are bisexual or unisexual. The flowers are in catkins or heads in the Reed Mace group, in a spadix in the Cuckoo Pint group, embedded in the frond in the Duckweeds. The perianth is absent or consists of scales in the Reed Mace group, absent or scale-like in the Cuckoo Pint group. The stamens are numerous in the Reed Mace group, few or numerous in the Cuckoo Pint group, one to two in the Duckweeds. The ovary is one- to two-celled in the Reed Mace group, one- (or more) celled in the Cuckoo Pint group, one-celled in the Duckweeds. The fruit is a drupe or utricle in the Reed Mace group, a berry in the Cuckoo Pint group.

Flowers are rare in the Duckweeds and always minute.

The Reed Mace group includes marsh or aquatic plants, and the Duckweeds are aquatic.

## 83. The Reed Mace Group.

Of the Order Typhaceae, including the Bur Reeds, there are about sixteen species, and two genera, *Typha*, *Sparganium*, of which some six species are found in the British Isles. They are natives of Temperate and Tropical regions. The members of this group show relationship with the Cuckoo Pint group, and the Screw Pine Group, to which last the Bur Reeds are closely allied.

They are aquatic or marsh plants, herbaceous, perennial. The habit is like that of the Grass group. The rootstock is creeping. The leaves have a sheath at the base, and are narrow, linear, blunt. There is no spathe, or if present it is not persistent.

The plant is monœcious. The inflorescence is in a round or oblong spike or head, with the male flowers above. The perianth consists of three or more hairs or scales, which are membranous and persistent. In the male flowers, which are above the female, there are few, one to six (or many), stamens, distinct or monadelphous, with slender anther-stalks, united by the filaments. The two-celled erect anthers are fixed by the base. They open at the sides. In the female flowers the free ovary is either stalkless or stalked and tapers into a slender, simple, persistent style, being one- to two-celled, with the stigmatic surface ventral, or unilateral. There is a single ovule,

pendulous from the top of the cell and anatropous. The fruit is small, leathery, spongy or dry, one-celled, a nut or drupe, and indehiscent. The seeds are single, pendulous, with abundant fleshy or mealy endosperm. The embryo is straight, round in section, with a cleft on one side.

Pollination is effected by the wind. As the male flowers are above the females, there may also be self-pollination, in spite of the flowers being unisexual, these plants being monœcious.

Wind also is instrumental in the dispersal of the fruits in *Typha*, whilst in the Bur Reeds the fruits are crowned by a stiff persistent style and the fruits may catch in the coats of animals.

In this group there are no plants with properties of economic importance, but the roots of Reed Mace are floury. In New Zealand the pollen has been made into cakes. Other uses for the Reed Mace are given in the description of the species chosen.

UNBRANCHED BUR REED (*Sparganium simplex*).

A common characteristic of the Bur Reeds is the long, narrow leaves. This is indicated in the generic name, which is the Greek for a little band. The specific name refers to the unbranched spike. Bur Reed has reference to the burr-like fruits. In general the plants have the reed habit.

This species is found throughout the British Isles, where it is fairly frequent, though more local than

*W. E. Mayes.* FIG. 97.—UNBRANCHED BUR REED (*Sparganium simplex*). *See page* 348.

FIG. 98.—GREAT REED MACE OR CAT'S TAIL (*Typha latifolia*).
*L. R. J. Horn.* *See page* 350.

the common Branched Bur Reed. It is found in Ireland.

Ponds, ditches, canals, streams, and river-banks are the habitat of this species. It is found in the fresh-water aquatic formation in waters relatively rich in mineral salts, in slowly-flowing waters, in the reed-swamp association.

Erect in habit this plant is not so large as the common species, from which the simple inflorescence (hence *simplex*) at once serves to distinguish it. The stem is simple, erect, or ascending. The rhizome is creeping, the stem being above the waterline so that the plant is half-submerged. The erect leaves are long, sometimes floating, keeled, triangular at the base, the sides flat. The sheath is not inflated but slightly furrowed.

The flowers are in spherical heads in a long raceme, each head rather distant, and not so numerous as in the common species. They are all stalkless, except those at the base, which are female, the males being above.

The perianth has three to six segments, which are sepaloid, and there are in the yellow male flowers three to six stamens, which are alternate with the perianth-segments when equal in number. There are one or two carpels in the larger female flowers with a single ovule, pendulous near the base of the ovary. The stigma is linear to awl-like. The style is short. The fruit is one-celled, slightly stalked, drupaceous, elliptic to spindle-shaped, narrowed both

ends, with a long beak. The seed is smooth and contains endosperm.

In height this species is 1 to 3 ft. It flowers in July and August, and is a herbaceous perennial.

Being a monœcious plant, with the male flowers above the female, cross- or self-pollination occurs, but as the stigma ripens in advance of the anthers the former is more general. Pollination is effected by the wind.

Being slightly hooked the fruits may be dispersed by animals. But the fruits are attached by a long slender stalk, and the fruit may be wind-dispersed, or if it falls in the water may be dispersed by water.

Blackweed, Unbranched Erect Bur Reed, are the only names.

SPARGANIUM SIMPLEX.—*In this illustration (Fig. 97) note the leaves are flat above, three-sided below, and clasp the stem at the base. The inflorescence is an unbranched spike. The male flowers are at the top, and sessile, the female stalked.*

GREAT REED MACE OR CAT'S TAIL (*Typha latifolia*).

There are two British species of Reed Mace, one, the larger, with the thick black spike, the smaller with a slender brown spike. In the former the leaves are broad (hence *latifolia*), in the latter they are narrower.

In the Greek name *Typha*, given by Theophrastus, from *typhos*, a pool, the habitat is indicated. This

plant is sometimes termed Bulrush, which applies more correctly to *Scirpus lacustris*. Bulrush is pole-rush or pool-rush.

Wherever there are suitable habitats the Great Reed Mace is to be found in all parts of the British Isles and in the Channel Islands, as well as in Ireland and northward in Britain to the extreme north of Scotland.

Pools, margins of lakes, river banks, watery ditches, streams, are the habitat of this plant, which forms a graceful ornament to every piece of water in which it grows in small or large patches, the tall stems and lank leaves swaying to and fro in the wind. It occurs in the fresh-water aquatic formation in waters relatively rich in mineral salts, in slowly-flowing waters in the reed-swamp association.

In habit the Great Reed Mace is erect, tall, with a thick, creeping rootstock below, the habit reed-like. The stem is round in section and stands high out of the water. The leaves are very long, in two rows, erect, linear, strap-shaped, nearly flat, longer than the inflorescence, and broad. They are sheathing at the base, elsewhere flat, more or less bluish-green.

The inflorescence is a dense continuous spike, sometimes a foot long. It consists of two parts, the male and female parts not being separated by a space. The upper, usually yellow, portion is male, with two to five stamens in the male flowers, the connective projecting beyond the anthers, and the flower is surrounded by a number of hairs. The anthers are

linear and closely packed. The female portion is black or brown, each flower being enclosed in hairs, the hairs soft, brown, in tufts, without bracts, and consisting of one carpel. The stigma is ovate to lance-shaped, oblique. The style is longer than the bristles. There is a single pendulous ovule, with the micropyle towards the base of the ovary. In fruit the upper part of the spike is a bare stalk, the lower thicker with the maturing of the ovaries into nuts enveloped in the rusty down. The ovary is at length stalked. The fruits are small, one-seeded.

From 3 to 7 ft. is the height of the Great Reed Mace. It flowers in June and July, and is a herbaceous perennial.

The Great Reed Mace is a monœcious plant. The flowers are wind-pollinated. As the males are above the female flowers, however, self-pollination may result, or cross-pollination if pollen be blown upon a neighbouring flower.

When the fruit, an achene, is ripe it is stalked, the stalk being long and slender; it bears long silky hairs. This ensures dispersal to a distance by the agency of the wind.

Being a common and well-known plant Reed Mace has a number of common English names, which, according to Britten and Holland, are Baccobolts, March or Marish Beetle, Blackamoor, Blackcap, Blackheads, Black-puddings, Bullrush, Bullsegg, Cat-o'-nine-tails, Cat's-spear, Cat's Tail, Cat's-tails, Club-rush, Dod, Dunce Down, Dunche Down, Flag,

Flax-tail, Holy Pokers, Lance-for-a-lad, Levers, Livers, Lyvers, Reed Mace, March Pestill, Mat-reed or Mat-weed, Pokers, Seggs, Serge, Son's Brow, Sootipillies, Water Torch, Whiteheads.

In pictures which represent the crucifixion of Christ, and the events leading up to it, a Reed Mace is placed in Our Lord's hands by the early painters in place of a sceptre.

Referring to this plant the Rev. Hilderic Friend writes: "This plant (*Typha latifolia*) is remarkable for its dark brown or black velvety spikes, which have in some places gained for themselves the name of Chimney Sweeper's Brush. In Devonshire the boys call them Blackheads. But when they get ripe and the velvet down loses its colour, they are called Whiteheads. Great confusion exists respecting this plant (the Reed Mace) and another which is also found in lakes and marshy places (*Scirpus lacustris*). Strange to say in Somersetshire the name of Bulrush is applied to the Common Rush (*Juncus*), and this is quite intelligible if we understand the name to be the same as Pole-rush or Pool-rush, which is said to be found in old writers. This was given to the plant from its growing in pools like the French *Jonc d'eau* and Anglo-Saxon *Ea risce*, only that the *Scirpus* is to be understood in these cases."

The Bulrushes which concealed Moses from Pharaoh were the Papyrus, *Papyrus antiquorum*, which is common in the Nile.

Formerly the Reed Mace was used for making

water-tight casks. The leaves were placed between the staves. The pollen has been used in place of Club Moss spores for flashing sparks of fireworks, being very inflammable. The plant is ornamental and might be grown in artificial pools.

TYPHA LATIFOLIA.—*The illustration (Fig. 98) gives an idea of the habitat. Note the long leaves in two rows overtopping the inflorescence, which is a long spike, with male flowers above, female below.*

## 84. THE CUCKOO PINT GROUP.

In the Order Araceæ are included amongst British plants Lords-and-Ladies and the Sweet Flag. The group includes 1000 species and 105 genera. They are natives of Tropical and Temperate regions, mainly Tropical.

They are related to the Screw Pine Group and the Reed Mace group.

The habit of the plants of this group is varied. Many are herbaceous plants, others are shrubs, some are climbing epiphytes. The Sweet Flag and others grow in aquatic or marsh vegetation. Aquatic type are represented by Pistia.

Adventitious roots are formed. In larger types there are aerial, climbing roots and absorbent roots. The former do not respond to gravity, the latter do respond to gravity and grow downwards.

The stem is occasionally monopodial, usually sympodial. The rootstock consists of a tuber or rhizome. There are scale-leaves below the foliage-leaves. In

the leaf-axils there may be accessory buds. The axillary shoot may be adnate to the main axis as in some Solanaceæ. The buds in the leaf-axils may be pushed to one side or break through the leaf-base. The leaves are variable, sometimes (as in *Arum*) net-veined or branched, and may be palmate or pinnate.

The tropical types are epiphytes, and are large climbing plants with aerial roots, and the roots below may die. The plant absorbs water from the soil, and is thus not epiphytic in that respect. Others begin life as epiphytes. In some plants the leaves have swollen leafstalks in which water is stored.

These plants as a whole have a dense spike or spadix and a coloured bract or spathe, of one leaf. There are no other bracts. The spadix ends a joint of the sympodium. The flowers are hermaphrodite, or the plant may be monœcious or diœcious. There may or may not be a perianth. It may be hypogynous or polyphyllous. There are usually six stamens, but there may be only one. They may be united into a synandrium in some exotic types, and several may be united. Staminodes may occur. The anthers are two-celled, and open outwards, or by terminal pores. The ovary is one- (or more) celled, and may consist of only one carpel. The style is simple, or the pin-headed or discoid stigma may be stalkless. There may be a single ovule or more than one. The fruit is a berry, one- (or more) celled. The outer covering of the seed may be fleshy. The seeds are one (or more) with or without endosperm, which may be fleshy or mealy.

Usually the stigma ripens before the anthers. The flowers may have a strong scent attractive to carrion flies, which carry pollen.

Some Araceæ are poisonous, with latex. There are starchy rhizomes in Arum, etc. Acrid properties are possessed by some types.

### Cuckoo Pint or Lords-and-Ladies (*Arum maculatum*).

There appears to be little or no meaning attached to the first Latin or Greek name. The second refers to the spotted leaves. The name Cuckoo Pint is a contraction of Cuckoo-pintle. Lords-and-ladies is applied in allusion to the two types of spadix which occur, a dark and a light one, the former representing a lord, the latter a lady. Holloway gives a quaint explanation: "So-called, I presume, from the stately appearance the blossom has, by being partially inclosed and protected by the sheath, so that the flower appears as though it were in a kind of state-chair or carriage."

This common plant is found in most parts of the British Isles, Great Britain, Ireland, and the Channel Islands. In the North of England it is found at an altitude of 1000 ft. There are some areas locally, however, where it does not grow and this peculiarity applies also to such plants as Dog's Mercury and Red Campion, as has been made clear by a careful survey of the vegetation of Leicestershire.

Woods and thickets, hedges, hedge-banks, are the

*B. Hanley.* FIG. 99.—LORDS-AND-LADIES (*Arum maculatum*). *See page* 356.

*The Author.* FIG. 100.—SWEET FLAG (*Acorus Calamus*). *See page* 361.

habitat of Cuckoo Pint. It is found on clay and loam in damp oakwoods, on siliceous soils in sessile oakwoods, on limestone in ashwoods, and in the marsh formation.

The habit is the rosette habit, with radical leaves and aerial stems in the form of scapes. There is a tuberous, acrid, starchy rootstock. The corms are annual, a new one being produced at the base of the stem. The leaves are vernal, radical, long-stalked, spear-shaped, or heart-shaped when young, with black or purple spots, glossy. The basal lobes are straight or slightly spreading. The leaves are dark green, and may be marked with white veins.

The flowers are borne on a short scape, which lengthens when there is fruit. The spathe is 6–8 in. long, obliquely bell-shaped, tapering to a point, and the convolute part narrowed above the base. It is erect, yellowish-green, with purple spots. Only the base persists. The plant is monœcious. The spadix is half hidden by the spathe. The upper part is club-shaped, yellow or purple, pink, crimson, easily rubbed off. The female flowers are at the base, and each consists of a single naked carpel. There is a row of rudimentary female flowers above these. Above the last are male flowers with two to four stamens. Above these are rudimentary male flowers represented by hairs turned downwards. The upper part of the spadix falls off. The fruit consists of berries, at first green, scarlet when ripe, borne on the naked stalk, with only the base of the spathe persist-

ing. There are two to three seeds with a netted testa.

In height the Cuckoo Pint is 6 to 10 in. or rarely a foot or more. The plant flowers in April and May, and is a herbaceous perennial.

The floral mechanism has already been described. The fertile flowers, male and female, are each surmounted by a ring of sterile flowers reduced to hairs. At first the female flowers are ripe, whilst later the stigmas secrete a sweet liquid, and the pollen is shed by the functional anthers. If a plant is examined in an early stage there will be found to be a large number of flies at the bottom of the spathe. They may be covered with pollen from the anthers of another flower. The flies have been attracted by the conspicuous spathe and spadix, the peculiar odour, and have managed to pass the *chevaux de frise* of sterile male flowers at the top, which point downwards. There is nothing in the early stage of the female flowers for the flies to live on and they struggle to escape. They cannot get out at this stage, the hairs being still an impediment to their egress. They come in contact with the stigmas, which are sticky, leaving pollen on them, and so cross-pollinating the female flowers. As these develop a sort of honey is secreted, and this the flies lick up. It is their reward for their unconscious labours. Now the anthers ripen and the flies become dusted with pollen. The hairs wither and the flies are allowed to escape, to find their way into another plant and begin again the useful work of cross-pollination.

When the anthers are ripe the stigmas are usually not receptive, so that self-pollination is prevented by the dichogamous nature of the flowers. If the pollen shed is not all carried off by the flies in their effort to escape it falls to the bottom of the spathe and a fresh set of flies may then become dusted with it.

Father Gerard, S.J., has stated that the nectar secreted by the ovaries has the effect of stupefying the flies, and that they are killed and digested by the plant, which is thus insectivorous if this be the case. Father Gerard considers this to be so from the occurrence of dried flies on the wall of the spathe. Another observer has noticed a similar sequence of events in an allied species. Moreover he thinks that self-pollination may occur since the dichogamy may not be complete.

Since the fruit is a juicy berry and brilliantly coloured, scarlet when ripe, even though it grows in woods and shaded places close to the ground, it offers an attraction to birds, in spite of its poisonous characters at least to man. Birds may thus serve very largely to disperse the fruits to a distance, eating the soft part and rejecting the seeds.

So many common names have been applied to this plant that only a selection of those in use now or in the past can be given, as Aaron, Adam-and-Eve, Adder's Tongue, Arrowroot, Bobbins, Calf's-foot, Cuckoo-flower, Cuckoo-spit, Dead Man's Fingers, Devil's Men-and-Women, Dragons, Friar's Cowl, Jack-in-the-box, Kings-and-Queens, Ladies and

Gentlemen, Lamb-in-a-pulpit, Lily-grass, Mandrake, Nightingales, Poison-berry, Priest's Hood, Schoolmaster, Snake's Meat, Starch-root, Wake-robin, etc.

The marks on the leaves are regarded as symbolic of drops of blood shed by Our Lord on the Cross.

> "Those deep unwrought marks
> The villager will tell you
> Are the flower's portion from the atoning blood
> On Calvary shed. Beneath the Cross it grows."

The Rev. Hilderic Friend refers to a story related by Gerard, which is traceable to the time of Aristotle: "It is related when bears were half-starved by hybernating, and had lain in their dens for forty days without any nourishment, save such as they were supposed to obtain from the sucking of their paws, they were completely and suddenly restored by eating of the Arum. This would appear to be one of the plants already spoken of, as possessing the power of restoring life."

In symbolic language Arum represents zeal or ardour. This is to be coupled possibly with the evolution of heat when it is in flower, though originally no doubt other reasons prompted the choice of this figure.

Poisonous plants and snakes are frequently connected, hence the name Adder's Meat or Snake's Food. The fruits are called Adder's berries. Adder is from the Anglo-Saxon, *attor*, which means poison, and the plant is in fact called Poison-berries.

The starch in the tubers formerly known as

Portland Arrowroot has been used as sago, but the tuber is acrid and it is not easy to get rid of this property, and the tuber is poisonous.

ARUM MACULATUM.—*In Fig.* 99 *are shown the berries with the remains of the spathe below.*

### SWEET FLAG (*Acorus Calamus*).

Being regarded formerly as a cure for diseases of the eye, the first name, derived from the Greek, *a*, without, and *kore*, pupil, is not inappropriate. The second name *Calamus*, a reed, refers to its reed-like habit. The English name chosen refers to its flag-like habit, and to its sweet scent, when the leaves are rubbed between the fingers.

There appears to be some doubt as to whether the plant is indigenous in all parts of the British Isles, where it occurs. But in England it appears to be indigenous and more common south of Central England, whilst in Scotland and Ireland it is only naturalised.* It is common in Norfolk and Suffolk.†

Ponds, ditches, streams, canals, and rivers, form the habitat of the Sweet Flag. It occurs in the fresh-water aquatic formation in waters relatively rich in mineral salts, in slowly flowing waters, in the reed swamp association, either closed or open.

The habit is erect. The rhizome is sympodial. The rootstock is thick, shortly creeping. The leaves

* † Where it may have been introduced owing to the useful properties it possesses or more rarely for ornament.

are radical, linear, erect, sword-shaped, with a thick subcentral mid-rib, flattened. The stem is similar. The leaves are isobilateral, as in the Yellow Flag (*q. v.*). They are aromatic or sweet-scented. The margins are wavy.

The scape is leaf-like, and has a prolongation of the stem beyond the spadix with a spathe, not enclosing the spadix. The spadix is quite covered with flowers, and lateral. The spadix is stalkless, hence the lateral appearance. It is dense, cylindrical, yellowish-green, curved. The six short perianth-segments are not longer than the two- to three-celled ovary. The fruit is inversely ovoid with a pyramidal top. There are six stamens. The fruit is a berry, with one to three seeds.

Three to four feet is the height of the Sweet Flag. It flowers in June and July, and is a herbaceous perennial.

The flowers are hermaphrodite, there being a hundred in each spadix. The stigmas ripen before the anthers. Ripe fruit is not produced in this country. In Asia, the fruit is formed, however, and this may be due to there being insects in that region which are adapted to cross-pollination.

Beewort, Cinnamon Sedge, Myrtle Flag, Sweet Flag, Myrtle-grass, Myrtle Sedge, Sweet Sedge, Sweet Seg, Sweet Rush, are names that this plant has received.

The rhizome was used as a stimulant and tonic. In Norfolk it was considered a remedy for ague. It

is eaten as a sweetmeat, after being candied, on the Continent. Tooth powders are made from it. Stockton Bitter is a medicine made from Gentian and this plant.

The aromatic leaves were formerly strewn on the floors of churches. At festivals in Norwich Cathedral it was employed in the same way. Possibly it may be the sweet cane mentioned in the Bible.

ACORUS CALAMUS.—*Fig.* 100 *shows a leaf bent over, showing the subcentral mid-rib, and the lateral stalkless spadix.*

### 85. THE DUCKWEED GROUP.

This is a small Order (Lemnaceæ) which consists of about eighteen species and three genera. They are related to the Water Plantain group and the Cuckoo Pint group. They are of universal range, found in standing water in all parts of the world.

They are floating, perennial herbaceous plants, green, and scale-like, with fronds, and no leaves, or no distinction between stem and leaf. They either have no roots or very slender simple roots, tipped by a membranous sheath. They are propagated by buds, as they rarely flower. All are aquatic. In the Autumn they put forth hibernating bulbils. There is no vascular tissue, or of a very low type.

They are monœcious plants. The flowers are extremely small and unisexual. There are one to three in a spathe, or they may be naked. There is no spadix. There is no perianth. The male flowers

consist of one to two distinct stamens. The anthers are one- to two-celled, and open transversely. The pollen is spherical. The female flowers consist of one carpel. There are one to six basal, erect, orthotropous or anatropous ovules. The ovary is one-celled. The style is short, and the stigma is simple, blunt or funnel-shaped. The micropylar end of the integument forms a lid to the seed. The fruit is bladdery and indehiscent. It is a bottle-shaped utricle. There is one seed or more than one. The testa is thick, and ribbed. The inner coat is thickened and discoid above the radicle. The endosperm is fleshy or absent, or slight, and there is an axile embryo, which is cylindrical, stout and straight.

### Ivy-leaved Duckweed (*Lemna trisulca*).

There is no apparent reason for the name *Lemna*, given by Theophrastus, the name heing the original Greek name. The second Latin name refers to the trifid character of the frond, which is Ivy-like in form.

This species is found in the British Isles from central Scotland, where it is rare, southward, and in Ireland where it is local, and the Channel Islands. It appears to be more widely distributed on the Continent.

Still waters form the habitat, such as ponds, ditches, or stagnant waters, *e.g.* canals. The plant is found

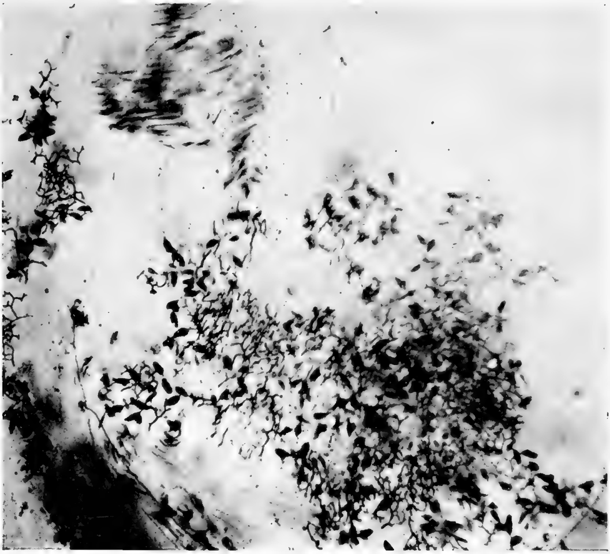
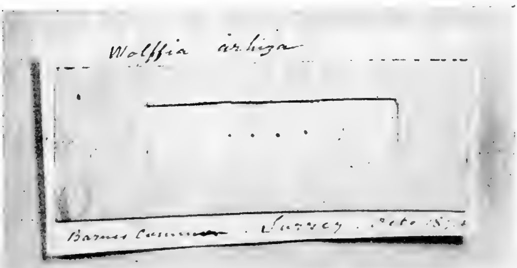


FIG. 101.—IVY-LEAVED DUCKWEED (*Lemna trisulca*), WITH AN HEPATIC (*Ricciella fluitans*).

*The Author.* *See page* 364.




*The Author.* FIG. 102.—ROOTLESS DUCKWEED (*Wolffia arrhiza*). *See page* 366.

in the fresh-water aquatic formation, in waters relatively rich in mineral salts, in nearly stagnant waters in the free floating-leaf association, and in the open reed-swamp.

The plant has the floating habit. The roots are solitary. The frond is thin, membranous, transparent, inversely ovate, elliptic to lance-shaped, tailed one end, serrate the other. The fronds are proliferous at right angles, giving the ivy-leafed appearance. Autumnal bulbils are produced which survive the winter. There is a groove under the edge of the frond and in this branches arise which remain in union with the parent shoot. The young frond is arrow-shaped, and persistent. The frond is narrowed at the base, with no epidermis, proliferous on one or both sides. The young fronds are numerous. They may reach a length of six lines and are half as broad when fully developed.

The flowers are borne in the grooves. The spathe is reduced, with two male flowers reduced to one stamen and one female flower with one carpel. The style is very short. The ovary has a single ovule. The testa is rough and grooved.

This is a floating plant of no appreciable height. It flowers in June and July, and is a herbaceous annual reproduced by shoots.

The plant is monœcious. It is half-submerged, and if pollen is produced it may be carried by small insects, but it is probable that the plant is propagated almost entirely by autumnal bulbils.

Fruit is not formed in this country and reproduction is mainly vegetative.

Frog's Foot, Grayves, are names for the Duckweeds generally, and the name cited is merely a book-name.

No properties are known for these plants, except that they afford food for water birds.

LEMNA TRISULCA.—*In the illustration* (*Fig.* 101) *the plant is seen to be of floating habit. The fronds can be distinguished as proliferous at right angles, which causes the chain-like arrangement.*

### ROOTLESS DUCKWEED (*Wolffia arrhiza*).

In the first Latin name is commemorated the work of a botanist, J. F. Wolff, who wrote on the Duckweeds in 1801. The second Latin name refers to the absence of roots.

Being the smallest flowering plant that is known to science, it is not surprising that its distribution, so far as ascertained, is limited, for it is probably largely overlooked. It has been found in Kent, Surrey, Middlesex, and Essex.

Ponds and slow streams form the habitat of this microphytic type. It occurs in the fresh-water aquatic formation, in waters relatively rich in mineral salts, in slowly-flowing streams in the floating-leaf association.

About the size of a grain of sand the fronds are $\frac{1}{2}$ in. long by $\frac{1}{4}$ in. broad, are thick, and swollen underneath, sub-globular, linear, oblong, flat above, loosely cellular below, cleft near the base, solitary

at the base. The young frond separates from within the base of the old one, and is soon detached. The walls of the epidermal cells are straight.

The flowers are minute and break through the upper surface of the frond. There is no spathe. There is a single stamen. The anther is rounded, stalkless, one-celled. The pollen is smooth. The ovary is rounded, one-celled. The style is short and the stigma flattened. There is a single erect ovule which is orthotropous. The fruit is a spherical ovule and indehiscent. The seed is oblique, with endosperm that is fleshy and not abundant.

The height of this diminutive floating plant is negligible. It flowers (not in the British Isles) in June and July. Propagation is by offsets as above, in this country.

If fruit is formed it is dispersed by the agency of water.

By reason of the existence of only one anther and the flowers being produced on the surface of the frond, not in a slit at the margin, the plant (formerly grouped with the other Duckweeds as *Lemna michelii*), is included in a separate genus, *Wolffia*.

WOLFFIA ARRHIZA.—*The illustration* (*Fig.* 102) *serves to give some idea of the size of the plant, which consists merely of a frond, without any roots.*

### Apocarpeæ.

In this series the flowers possess a coloured perianth which is in two series, or green and in one series, or imperfect or wanting. The ovary is superior, apocarpous, or monocarpellary. The seeds do not possess endosperm. The end of the embryo at which the cotyledons are situated is narrower, hooked, or coiled, and rarely straight.

The Alismaceæ or Water Plantain group and the Naiadaceæ or Pondweed group are included in this series.

In the former the flowers are mainly hermaphrodite, variable in the latter.

In Alismaceæ the perianth is six-partite, four-partite in Naiadaceæ, with an equal or greater number of stamens. There are numerous carpels in the Alismaceæ, one to four in the Naiadaceæ. In the former the fruit consists of many achenes. In neither groups do the seeds contain endosperm. In both the radicle is very large. In each case the plants are aquatic or marsh plants. In the Alismaceæ the flowers are large and coloured, in the Naiadaceæ they are small and green. These distinctions serve well to separate the groups.

### 86. The Water Plantain Group.

Some fifty species arranged in ten genera are included in the Order Alismaceæ. They are natives

of Temperate and Tropical regions. Amongst British types are included the Water Plantain, Elisma (by some included in Alisma), Star-fruit, Arrow-head, and Flowering Rush. They appear to be closely related to the next group, the Order Naiadaceæ, or Pondweed group.

Bentham and Hooker make two groups of them, Alismeæ, including Alisma, Elisma, Damasonium, all bisexual, Sagittaria unisexual, with green sepals, large fugacious petals, ripe carpels indehiscent, solitary basal ovules, or numerous ovules in the inner angle of the carpel; Butomeæ, including *Butomus*, with the petals and sepals alike, ripe carpels dehiscent, numerous ovules on branching parietal placentas.

They are aquatic or marsh plants, and all are herbaceous. The rhizomes are perennial. The leaves are radical, and the aerial stems are scapes. The leaves may be erect or floating, or in early stages current leaves of the ribbon type. Small scales occur in the axils of the leaves. There are laticiferous vessels.

The inflorescence is branched, racemose, then cymose, terminal, umbel-like in the Flowering Rush. The flowers are mainly hermaphrodite or pistillate and staminate, and regular. The perianth is free, six-partite, in whorls, the inner petaloid and larger, the outer sepaloid. There are six to eight or nine or more stamens which are hypogynous, with free anther-stalks. The anthers are oblong and open outwards. The ovary is superior and consists of

three, six, or more apocarpous carpels, distinct and separate at length, the carpels opening at the suture or not at all. The styles are short or wanting. The stigmas are terminal, simple or feathery. There is a single ovule or more, anatropous or campylotropous.

The fruit is a group of leathery carpels or achenes that do not open, or follicles. There is a single seed (or more). The testa is leathery or membranous. There is no endosperm. The embryo is straight or hooked, horseshoe-shaped. There are no raphides.

As the inner perianth-segments are petaloid they serve to attract insects. Some types possess honey as *Butomus*, others, as Sagittaria do not.

The fruits are to a large extent dispersed by water. Water Star Fruit has fruits with large, long beaks adapted to dispersal by animals.

Many of these plants are beautiful and suited to the garden. They are of no economic importance.

### Water Plantain (*Alisma Plantago-aquatica*).

Possibly the first Latin name applied by Pliny is to be derived from the Celtic, *alis*, water. But it is uncertain to what plant it was originally applied. The second Latin name and the English name have reference to the habit of the plant, like a Plantain, but aquatic.

Though generally distributed throughout the British Isles, especially in the lowlands, where

*B. Hanley.* FIG. 103.—WATER PLANTAIN (*Alisma Plantago-aquatica*). *See page* 370.

*W. Bell.* FIG. 104.—ARROW HEAD (*Sagittaria sagittifolia*). *See page* 372.

aquatic vegetation is more universal, the Water Plantain is not so abundant in North Britain as in the Midlands and East Anglia. It occurs in Ireland and the Channel Islands.

Lakes, ponds, the edges of rivers, and streams or ditches form the habitat of this plant. Though usually found in the reed swamp it is to some extent amphibious and may be found growing on dry land. It grows in the fresh-water aquatic formation, in waters relatively rich in mineral salts, in slowly-flowing streams, in the reed swamp association.

There is a perennial rootstock (which is more or less bulbous, the base being swollen), from the thick sheathing bases of the leaf-stalks, and fleshy. The leaves are radical, erect, stalked, ovate to lance-shaped, the base acute, blunt or nearly heart-shaped. There are five to seven ribs. The young leaves are submerged or floating.

The flowers are small, lilac or pale-rose colour, with a yellow claw, in a pyramidal panicle, on a long scape, with whorled compound branches. The sepals are ovate to oblong, twice as long as the styles, which are ventral below the top of the inner edge of the carpel. There are twenty to thirty blunt, inversely ovate carpels, which are in one whorl, flattened at the margin, and arranged in a single ring around a broad, flat, central axis. There are six stamens by doubling of the outer whorl, coherent below and forming a honey-gland.

In height the Water Plantain is 1 to 3 ft. It

flowers from June to August, and is a herbaceous perennial.

The honey is half-concealed in the honey-gland in a ring at the base of the stamens. The anthers and stigma ripen together. As the anthers open outwards the flowers may avoid self-pollination, and, being fairly conspicuous, be cross-pollinated by the insect-visitors, which are chiefly flies.

The achenes when ripe fall in the water.

There are few vernacular names, as De'il's Spoons, Great Thrumwort.

This is a plant which might well be cultivated as an ornamental garden flower for the lake garden.

ALISMA PLANTAGO-AQUATICA.—*In the illustration (Fig.* 103) *the aquatic habitat is depicted, and the leaves, which are lance-shaped, are half submerged, as is also the long pyramidal panicle.*

### ARROW-HEAD (*Sagittaria sagittifolia*).

The scientific names of the Arrow-head are together pleonastic, as both together refer to the same thing, the shape of the leaves—as indicated by the English name. This nomenclature is not so bad as the modern system of bird nomenclature, where the same name recurs three times (in trinomials) with sometimes, however, onomatopæic significance.

Like the last plant described the Arrow-head is more or less universal in the British Isles in the lowlands where aquatic vegetation is most extensive.

It is only naturalised in Scotland. In Ireland it is quite local.

Ponds, meres, streams, canals, ditches, form the habitat of Arrow-head, usually clear shallow water. It is found in the fresh-water aquatic formation in waters relatively rich in mineral salts, in nearly stagnant waters in the floating-leaf association.

The stem is swollen below and produces stolons, the rootstock being creeping, with bulbous tubers, which are rounded in winter. There are early submerged current leaves, or leaf-stalks of the ribbon type, linear, membranous. The leaves are radical, and later rise above the water. At first, as in Arum, they are not arrow-shaped, but oblong or nearly heart-shaped below. The ultimate type has the basal, spreading, lance-shaped, straight lobes nearly as long as the terminal lobe, long-pointed. The leaf-stalk is three-sided, and long and stout.

The flowers are white, large, with a purple spot at the base, borne on a long, leafless scape, longer than the leaves, in three to five distant whorls, with three to five flowers in each. The bracts are short, blunt, membranous. The three inner perianth-segments are twice as long as the outer green ones. The plant is monœcious. The lower whorls of flowers are female, on short ultimate stalks; the upper long-stalked ones are male, and are larger flowers. The petals fall at length. The anthers are purple. The ripe carpels are numerous, and flattened at the margin, obliquely inversely ovate, with a short point, with

broad thick wings. The seeds are erect, with a hooked embryo, shining, not wetted by water.

In height Arrow-head varies from 6 to 18 in. It flowers from July to September, and is a herbaceous perennial.

No honey is secreted by the flowers, which, however, have numerous stamens, and are pollen flowers. Being conspicuous they may be much visited by insects, a necessity for monœcious plants.

As the seeds are not wetted when they fall into the water, they are water-dispersed.

Adder's Tongue, Water Archer, are the only other names.

SAGITTARIA SAGITTIFOLIA.—*The illustration* (*Fig.* 104) *shows the habitat of the plant, which grows in the reed swamp, or is half-submerged. The sagittate leaves and long petioles are readily discernible.*

## 87. THE PONDWEED GROUP.

In the Order Naiadaceæ, as defined by Bentham and Hooker, representatives of other orders now recognised are included, as Potamogetonaceæ, Naiadaceæ, Aponogetonaceæ* (not British), and Juncaginaceæ. They make, however, five tribes: Juncaginaceæ, including *Triglochin*, *Scheuchzeria*; Potameæ, including *Potamogeton* and *Ruppia*; Zannichellieæ, including *Zannichellia*; Zostereæ, including *Zostera*; and Naiadeæ, including *Naias*. A type of each of these tribes is described hereafter.

* A species has recently been found in Great Britain.

There is some appropriateness about the term Naiadaceæ since all these plants are hygrophilous and either aquatic or marsh plants, found in fresh or salt water.

Some one hundred and twenty species are known included in sixteen genera. The group is related to the last group.

These plants are either herbaceous marsh plants or, when aquatic, of the floating or submerged type. The rootstock is creeping. The stems are long with long internodes (or the plant may be stemless), jointed, branched, and slender. As a rule the leaves are sheathing below, or have sheathing stipules within the leaf-stalk sheath, and are alternate or opposite or in two rows, floating. There may be no stipules. The veins are parallel.

The flowers are small, hermaphrodite (or the plant may be monœcious), green, in the axils, solitary or in spikes, arising from a sheathing bract. There is either no perianth, or, if it is present, it is tubular or cup-shaped, and consists of two to four scale-like segments, inferior, valvate. There are one, two, four, or six stamens which are hypogynous. The anthers are one- to two-celled. The ovary is superior and consists of one to four carpels, or of two, four, or six carpels, with a single ovule in each carpel, erect or pendulous. There is a single style and a separate or two to four stigmas. The fruit consists of one, two, three, four, or six utricles, achenes or drupes. They are one-seeded. The seed is solitary. There is a membranous

testa. No endosperm is formed. The embryo may be straight or curved.

Some flowers, as in Triglochin, are wind-pollinated. *Zostera* and *Naias* are unique in their methods, pollination being effected under water. The pollen-grains are long threads of the same specific gravity as water. In *Ruppia* pollination is largely as in *Vallisneria*. The flowers in Potamogetonaceæ are wind-pollinated. In *Zannichellia* pollination is under water as in *Zostera*. The pollen is, however, not confervoid, but spherical.

The fruit is dispersed by the agency of water.

The leaves of *Zostera* are used commercially, otherwise the group is unimportant from the economic standpoint.

### Arrow Grass (*Triglochin palustre*).

In the English name and first scientific name, from the Greek, reference is made to the three-pointed carpels, in the fresh-water marsh type. The second Latin name denotes the habitat.

This plant is of universal occurrence in the British Isles in suitable habitats up to the Shetlands. It is found also at an altitude of 2000 ft. in the Highlands. It is native in Ireland and the Channel Islands.

Marshes, wet meadows, or the shallow margins of streams, are the habitat of the Arrow Grass. It is found on clay and loam in neutral grass-land, in sub-

*The Author.* FIG. 105.—ARROW GRASS (*Triglochin palustre*). *See page* 376.

*The Author.* FIG. 106.—HORNED PONDWEED (*Zannichellia palustris*). *See page* 381.

maritime fen pasture, on upland moors, on grass moor, and amongst Arctic-Alpine vegetation.

In habit the Arrow Grass is grass-like and of the rosette type. The stem is swollen below. The rootstock is tufted, and there are a few, slender, creeping runners. The leaves are radical, slender, limp, faintly grooved above, succulent, swollen and sheathing below, half round in section.

The flowers are borne on a slender scape, in a long raceme, which lengthens in fruit, on short ultimate flower-stalks. The flowers are small, yellowish-green, stalkless at first. The perianth-segments are broadly ovate, and purple at the border. There are six stamens in two rows of three each. The anthers are purple. The stigmas are feathery and project beyond the nearly equal perianth-segments. The perianth-segments fall, and the fruit, which is appressed to the scape, and club-shaped or hastate, lengthens, tapering below. When ripe it separates from below upwards into three carpels with a central axis. The carpels are round at the back, narrow below, with the axis three-sided. There may be three abortive carpels between the three fertile ones.

In height Arrow Grass varies from 6 to 12 in., but I have found it to be nearly 18 in. occasionally. It flowers from May to September, and is a herbaceous perennial.

The flowers are inconspicuous. The stigma ripens two to three days in advance of the anthers. By secondary growth the inner whorl of perianth-

segments is higher on the axis than the outer stamens. The flowers are wind-pollinated. Pollen collects in the hollow bases of the perianth-segments just below the stamens. It remains till wind disperses it. The stigmas are brush-like.

The carpels when ripe surround a central axis or beak, and have long, sharp, spine-like lobes, which catch in the coats of animals, which thus disperse the fruits.

There is no other common English name beyond the one cited.

There is a maritime species allied to the inland one described.

TRIGLOCHIN PALUSTRE.—*The illustration* (*Fig.* 105) *shows the long, slender leaves and the slender scape, with flowers in a raceme, and spinose fruits.*

### BROAD-LEAVED PONDWEED (*Potamogeton natans*).

In the first Latin name, derived from the Greek, *potamos*, river, *geiton*, neighbour, the aquatic habit is indicated, and the second Latin name refers to the floating leaves.

There appears to be some reason for regarding the Pondweeds as originally derived from land plants. In some the leaves are floating, in others the plant is wholly submerged, whilst others may live almost on land as *P. heterophyllus*, or in shallow pools as *P. polygonifolius*. The one under description is near the ancestral type, being least modified to aquatic conditions.

This species is found in all parts of the British Isles, as far north as the Shetland Isles, and in Ireland and the Channel Islands.

Lakes, ponds, stagnant or running water, deep or shallow ditches, etc., are the habitats of this species. It grows in the fresh-water aquatic formation in waters relatively rich in mineral salts, in nearly stagnant waters, in the floating-leaf association, and in waters poor in mineral salts, in peaty moorland lochs, and in the open reed-swamp.

The plant has the aquatic habit. The rhizome is sympodial, creeping. The stem is round in section and simple. The branches are erect and leafy. They die down in winter, only the rhizome persisting. The leaves are long-stalked, the upper leaves floating. There are no submerged leaves, or if so they are phyllodes. The floating leaves are elliptic to lance-shaped, ovate, oblong, leathery, thick, opaque, rounded below or heart-shaped, or tapering, with several longitudinal nerves, alternate, the blade running down the leaf-stalk. The margins are incurved, folded below. The leaf-stalk is jointed just below the limb, plane to concave. If flattened a ridge is formed on each side of the base. The submerged leaves are thin, narrow, stalked, linear to lance-shaped, bristle-like, or mere leaf-stalks. The stipules are free, very long, axillary, closely sheathing, long-pointed.

The flowers are in a dense, cylindrical spike, projecting above water, an inch or more long, on a stout

stalk, not enlarged upwards. The parts of the flower are in fours. The outer perianth-segments are stalked, roundly rhomboidal. There are four stamens in two whorls, and four carpels. The anther-cells are not parallel. The anthers are stalkless and from the connective a cup-shaped expansion like a perianth-segment grows out. The fruit, a drupelet or nut, is dry, large, keeled on the back when dry, rounded when fresh, with a convex ventral margin, green, slightly flattened, ovoid, straight, with three dorsal ribs and a short beak.

This is a floating plant reaching a length of several feet, flowering in June and July, and is a herbaceous perennial.

The flowers rise above the surface of the water. The stigma ripens first, and, as in other pondweeds, the flowers are wind-pollinated.

As the outer layer of the pericarp contains air, the achene floats on the surface and is carried to a distance, finally sinking when the air escapes.

Batter-Dock, De'il's Spoons, Flatter-dock, Fish-leaves, Water Spike, and Tench-weed are the names applied to this species. The last name reminds the fisherman that the Pondweed is an effective entanglement preventing him very often from landing his tench.

POTAMOGETON NATANS.—*The Frontispiece gives a good idea of the habitat of this plant and the social habit, the plant being a floating-leaf type.*

HORNED PONDWEED (*Zannichellia palustris*).

This plant is named in honour of a Venetian apothecary and botanist, John Jerome Zannichelli, who wrote a history of the plants of his district, and died in 1729. The second Latin name is intended to indicate the habitat, but the plant is truly aquatic, and not a marsh plant. In the English name the horned fruits are referred to.

Frequent in most parts of the British Isles up to the Orkneys the Horned Pondweed is found less frequently in the west of Scotland where there is less aquatic vegetation. It occurs in Ireland and the Channel Islands.

Ditches and fresh-water ponds, lagoons, or stagnant water, streams, etc., are the habitat of this species. It is found in the fresh-water aquatic formation in waters relatively rich in mineral salts, in stagnant waters in the submerged-leaf association.

In habit this plant is of the Pondweed type. The stem is slender, bristle-like, branched, the branches spreading, submerged. The leaves are opposite, slender, thread-like, linear, more or less whorled, bright green. There is a small sheathing membranous stipule embracing the stem.

Being a monœcious plant, the male and female flowers are separate. The female flower is terminal, the male arising from the axil of a lower bracteole, and from the axil of the upper bracteole a new branch

may spring with male and female flowers. In the male flower are one or two stamens. The female flower contains four free, single carpels, with a small, entire, cup-shaped perianth or spathe. The ovaries are stalkless within the bracteoles with a short style and broad disc-shaped stigma, half as long as the nut. The anther-stalks are slender. The anthers are two- or four-celled. When ripe the carpels or achenes are stalked or stalkless, narrow, curved, flattened, with a smooth tubercled keel, with a beak, the remains of the style.

In length the Horned Pondweed is 12 to 18 in. It flowers from May to August, and is a herbaceous annual.

The plant being monœcious pollination must be effected by outside agency, and the flowers are pollinated as in *Zostera*, but the pollen is spherical, not long and thread-like. The male flowers are long-stalked.

The fruits or achenes are dispersed by the agency of water.

No other name for this plant is known except the one cited.

ZANNICHELLIA PALUSTRIS.—*Note in Fig.* 106 *the long, linear leaves, with a whorl-like arrangement, also the beaked achenes, in fours.*

DWARF GRASS WRACK (*Zostera nana*).

In the first Latin name, derived from the Greek *zoster*, girdle, the strap-like or ribbon-like leaves are described. In the second Latin name the distinctive character of this species, its small size, as contrasted with the more common *Z. marina*, is indicated.

This is one of the few marine types of British flowering plants. Its distribution is thus confined to maritime counties. It is a rare plant, found in several areas from Forfar and Argyll to Sussex and Cornwall, on the British coasts, and in Dublin Bay in Ireland.

Muddy estuaries, or sandy shores between high- and low-water mark are the habitats of this plant. It is found in the salt-marsh formation, in what is known as Zosteretum or the Grass Wrack association attached to pebbles or rock fragments in sand or mud.

The Grass Wracks have a ribbon-growth type of habit. The stem is creeping below, and rooting at intervals. The branching is monopodial, and as the branches grow upward it becomes sympodial, the axillary shoot being united to the main axis for some distance. This mode of branching is characteristic of a rhipidium, as in Iris. The leaves are long, slender, linear, one-veined, sheathing below.

The inflorescence is a flattened spadix, and when the plant is in flower enclosed in a spathe, the sheath of the uppermost leaf. The spadix is short with two to five clasping bands, the margin with membranous

appendages bent inwards, few-flowered, the flower-stalk being thread-like, pale-coloured, half as broad and as long as the spathe, which is swollen above the stalk, oblong to lance-shaped, the blade short. It is open down one side, the flowers being borne on the side of the spadix. The stamens and pistil are in two vertical rows, a carpel and a stamen alternately. A retinaculum occurs on the outer side of the spadix next the carpel. The carpel has the midrib facing outwards. There is a single ovule with two stalkless stigmas. The stamens are made up of two half-anthers, united by a small connective. The carpel and stamen on the same level form the flower and a retinaculum is its bract. The fruit, an achene, is short, smooth, and finely furrowed, the seeds short, shining black when ripe.

The plant is submerged, 3 in. long. It flowers from April to August, and is a herbaceous perennial. In winter it hibernates like other aquatics.

Pollination is peculiar and effected by the agency of water. The flower is submerged. The pollen-grains are long threads of the same specific gravity as salt water and so able to remain at any level. When discharged they float at any level. The stigmas are very large, and the styles are long, hair-like, projecting from the spathe to catch the pollen, which has no extine. This is similar to the way in which plants are pollinated by the wind.

The achenes are dispersed by the agency of water.

*W. E. Mayes.* FIG. 107.—DWARF GRASS WRACK (*Zostera nana*). *See page* 383.

*The Author.* FIG. 108.—HOLLY-LEAVED NAIAS (*Naias marina*). *See page* 385.

Dwarf Grass Wrack or Sea Wrack is the only name.

The leaves of the larger species have been used for packing glass and china, stuffing cushions in Venice. In some places the leaves have been used as manure.

ZOSTERA NANA.—*In Fig.* 107 *the habit of the plant is shown, also the long ribbon-like leaves.*

### HOLLY-LEAVED NAIAS (*Naias marina*).

In the first Greek name the aquatic habitat of this plant is indicated, and the second or specific name refers to its marine predilections. The English name specially refers to the character of the foliage.

Being like the last, a maritime plant, the Holly-leaved Naias is found near the coast, and grows in Hickling Broad, Norfolk. In plant-beds of early age two species, *Naias minor* and *N. graminea,* have been found by Mr. Clement Reid, F.R.S. The last has been found also in a canal at Redditch, Lancashire, where it was possibly introduced with foreign (Egyptian) corn, being found in the Mediterranean area, and in the Tropics in the Old World. The former occurs in Europe and Asia as a recent species.

Broads in Norfolk constitute the only British type of habitat, where it is found in the aquatic formation in the submerged-leaf association.

This plant has more or less the Pondweed habit

and is submerged. The stem is slender, regularly but sparingly branched from near the base, with tooth-like wings at intervals.

The leaves are opposite, linear, strongly spinous, toothed, ternate, with a narrow blade, with rounded entire or sub-entire sheaths. The upper internodes and backs of the leaves may be spinous.

The plant is diœcious. The flowers are solitary. The male flowers are enclosed in a membranous sac-like spathe, and possess a single anther, terminal on the axis, one- or four-locular, enclosed in two sheathing perianths. The female flowers consist of a single ovary with one carpel, which is naked or surrounded by a perianth-like structure. There are three stigmas. The fruit is a drupe, ellipsoid, succulent or ovoid, and narrowed into the short, persistent style. The seed is ovoid. There is a single ovule, anatropous, terminal. There is no endosperm. The embryo is straight.

In height the plant is 3 to 9 in. It flowers in July and August and is a herbaceous perennial.

Being a diœcious plant, pollination must be effected by outside agency. This is carried out by the agency of water as in *Zostera*, but the pollen is not thread-like, but spherical or oblong, as in *Zannichellia.*

The fruit, a $\frac{1}{4}$ in. long, is dispersed by the agency of water.

NAIAS MARINA.—*In Fig.* 108 *note the opposite spinous leaves with fairly long internodes.*

## Glumaceæ (Summary).

(*Introductory Volume, p. 215.*)

The plants included in this series have flowers with no perianth, or if represented it consists of bristles or less frequently of scales. The flowers are in spikes, in the axils of overlapping glumes or bracts. The ovary is one-celled with a single ovule. There are two to three styles or stigmas. The seeds contain endosperm, and the embryo is small.

There are two groups embraced in this series, the Cyperaceæ or Sedges, and the Graminaceæ or Grasses. The flowers may be unisexual or bisexual in the former. In the Grasses the flowers are usually complete. There is no perianth, or mere bristles, in the Sedges. It consists of two scales in the Grasses, or lodicules. There are one to three stamens in Sedges, three as a rule in Grasses. In the former the anthers are fixed by the base, in the Grasses they are versatile. In both the ovary is unilocular. In the Sedges there is a single style, and two to three papillose stigmas. In the Grasses the stigmas are one to two and hairy or feathery. The fruit is flattened or three-angled in Sedges, rounded or grooved on one side in Grasses. The embryo is below the endosperm in the Sedge group, at the side in Grasses.

In Sedges the stem is solid, three-angled, in Grasses usually hollow, except at the nodes. The sheath is entire in the former, split in the latter.

## 88. The Sedge Group (Summary).

(*Introductory Volume, p. 215.*)

In the Order Cyperaceæ are included amongst British types *Cyperus*, Galingale, Heleocharis or the Spike Rushes, the Bulrushes, Cotton-grasses, Beak Sedges, Bog-rush, Prickly Twig Rush, *Kobresia*, and the Sedges.

Bentham and Hooker make four tribes, Scirpeæ, including the first four, Rhynchosporeæ, including the next three, Sclerieæ, embracing *Kobresia*, and Cariceæ, including the Sedges. Pax reduces these to two groups—Scirpoideæ and Caricoideæ. The anatomy has been worked out by Clarke and others.

In this volume types of the last three tribes are described, the first having been described in the Introductory Volume (p. 217).

There are some 2500 species and sixty-five genera of plants of the Sedge group. In distribution they are cosmopolitan. Most of them are moisture-loving plants found in marshes, fens, moors, or in the reed-swamp in the aquatic formation. Many species form wide associations as the Cotton-grass, Bulrush, Sedges.

The group is related to the Restiaceæ in possessing no regular perianth, and to the Graminaceæ, from which it differs in the absence of an inner scale or palea between the flower and the axis of the spikelets, and in the simple, not feathery, stigmas. The sheaths are entire in the Sedges, split in the Grasses. The

glumes are brown in plants of the Sedge group, green or purplish in the Grasses.

The habit is typical or Sedge-like, or like that of the Grasses. The rhizomes are creeping, sympodial. The new shoot of each year is attached throughout the length of an internode to the stock or first main shoot. The stem is usually solid, angular, with three rows of leaves. The plants are generally perennial. The leaves are grass-like with closed sheaths at the base.

The inflorescence is a spike or panicle, with flowers in spikelets which may form a cyme or sympodium, being a pseudo-spikelet. They are uni- or bi-sexual. They are borne in the axils of a glume, usually naked, sometimes with a perianth, or six or more small, hypogynous scales or hairs as in Cotton-grasses. The anthers and styles project beyond the rounded, annular or flattened spikelets, and are solitary or terminal, or several in a terminal cluster (simple or compound), spike, or umbel. The spikelet, enclosed in an outer glume, consists of several overlapping glumes, with a single flower in the axil of each. The glumes are concave, sometimes rigid, in two rows, or surrounding the rachis. The lower glume in each spikelet is as a rule empty. In Sedges there is an outer second glume in the female flowers, the utricle or perigynium, of one folded or two connate bracteoles. There are three stamens or two, hypogynous, with linear, flat anther-stalks. There may be a row of bristles or abortive filaments. The

anthers are erect, entire at the tip, linear, fixed by the base, opening inwards, two-celled with a claw at the tip. The ovary is one-celled, with three or two carpels, in the same or a distinct glume. There is a single style, two to three slender, linear stigmas, papillose all over. The ovule is single, basal, anatropus, erect. The fruit is an achene, small, flattened, the style often two-cleft, or three-angled, when three-cleft, enclosed in the perigynium in Carex. The testa does not adhere to the pericarp. The seed is solitary, erect, the testa membranous. The endosperm is floury. The embryo is small, at the base of the endosperm.

The flowers are wind-pollinated.

No properties of economic importance are afforded by the plants of the Sedge group, except that Galingale was formerly used medicinally, the cotton of Cotton-grasses has been used for wick or for weaving or stuffing pillows, and Sand Sedge is useful on the coast for binding the sand together.

### Bog-rush (*Schœnus nigricans*).

Some of the species of this genus, *Schœnus*, have been used as cordage, hence the generic name. The second refers to the black sheaths. The habitat and habit are indicated in the English name.

Local in its occurrence, and restricted to wet regions, or the west of England and North Britain as a whole, Bog-rush is found from Shetland to Cornwall.

*The Author.* FIG. 109.—BLACK BOG-RUSH (*Schœnus nigricans*). *See page* 390.

*The Author.* FIG. 110.—KOBRESIA (*Kobresia caricina*). *See page* 392.

In the Highlands it ascends above 1000 ft. It occurs in Ireland and the Channel Islands.

Turfy bogs, marshes in the neighbourhood of the sea or wet regions, wet moors, are the habitats of the Black Beak-rush, as the plant is also called. It is found on sandy soil in the heath association, on wet heaths, being abundant on the Cornish heaths, in valley moors, in the Blue Moor grass association, and in the White Beak Sedge association.

Tufted in habit, Black Beak Sedge has a short, stout, branched rootstock, with strong black fibres. The stems are stiff, rush-like, round in section, naked, the leaves and sheaths forming matted tufts, dense and hard, wiry, leafless above. There are numerous, reddish-brown or black, smooth, shining sheaths, some ending in erect leaves, not so long as the stem. The leaves are radical, stiff, wiry, round in section, with the margins convolute.

The flowers are terminal, rounded, inversely ovoid, the spikes dark, reddish-brown and shining, with bristle-like bracts, longer than the spike.

There are several dark brown, shining spikelets (five to ten), erect, stalkless, linear to oblong. The glumes are pointed, with a roughish, prominent keel on the edge, roughly in two opposite rows, oblong to lance-shaped, somewhat acute, the four upper with flowers in the axils, the short lower ones empty. The bristles are barbed with one spine upward and short. There are three stigmas.

In height the Bog-rush varies from 6 in. to 2 ft.

It flowers in June and July, and is a herbaceous perennial.

As in most, if not all, of the Glumaceæ, the flowers are pollinated by the wind. The stigmas ripen in advance of the anthers.

The fruit is an achene, which falls, when ripe, near the parent stock.

Bog-rush, Clock-seaves, Lawk, Ling, Black Beak-rush are the only names for this plant.

SCHŒNUS NIGRICANS.—*In Fig.* 109 *note the rush-like stems with few short leaves, the terminal flowers, and the bristle-like bracts longer than the spikes.*

## KOBRESIA (*Kobresia caricina*).

This plant is named in honour of M. de Kobres, of Augsburg, who was a supporter of botanical research. The second Latin name indicates the sedge-like habit.

In Britain this plant is very rare, being restricted to a few counties in the north of England and Scotland, York, Durham, Westmorland, Argyll and Perth, where it grows at an elevation of 2500 ft.

Upland moors, alpine marshes, and wet places in general form the habitat of this local species, which is found only in upland moors at considerable altitudes where the atmosphere is moist and humid.

In habit it is sedge-like and densely tufted like the last. The rootstock is short. The plant is of low

stature, with erect stems, which are rigid, round in section, and leafless above. The leaves are radical, not so long as the stem, wiry, bent back, grooved, the margins convolute as in plants adapted, as in the Black Beak-rush also, to physiological drought. The leaves may sheath the base of the stem, and are spreading.

The flowers are in a narrow spike. There are four to five brown, short spikelets, which are more or less in two rows, stalkless, cylindrical. The lower flowers are abortive and the second are female, with an ovary and three-cleft style in each glume. The male flowers are the upper terminal spikelets, and one terminal flower in the lateral spikelets, made up of stamens within each glume. The lower may be compound or branched. The bracts are small, the lowest having a rigid toothed point. The glumes are rigid, ovate to oblong, blunt, pale brown. The nut is as long as the glumes, linear, beaked, pale.

In height Kobresia varies from 4 to 9 in., but is generally 6 in. It flowers late, in August and September, and is a herbaceous perennial.

The flowers are pollinated by the wind, the stigmas ripening in advance of the anthers.

The nuts fall when ripe near the parent plant.

KOBRESIA CARICINA.—*Fig.* 110 *shows the sedge-like habit, the tufted character, the wiry bent-back leaves, some sheathing the base of the stem; also the narrow spike with four to five spikelets, in two rows.*

### Pond Sedge (*Carex riparia*).

The name Carex was applied by Virgil. Its etymology is uncertain. The second Latin name denotes that the plant grows at the margin, or on the banks, of ponds, etc.

This Sedge is common in all lowland parts of the British Isles up to Banff wherever there is aquatic vegetation, but it is local in Ireland. It occurs in the Channel Islands.

River banks, ditches, wet places, constitute the habitat of this plant, which often helps to form a transition from aquatic vegetation to marsh-formation, or the vegetation of wet swamps in general. It is found in the fresh-water aquatic formation in waters relatively rich in mineral salts, in nearly stagnant waters, and in slowly-flowing waters in the reed-swamp association, and in the fen-formation in swamp carr.

Sedge-like in habit the rootstock of this plant is creeping and tufted. The stems are tall, stout, three-angled, rough at the angles. The leaves are very broad, flat, bluish-green, keeled, the edges of the sheaths filamentous. There is a broad bract which overtops the stem.

The flowers are in very large spikelets. There are one or more terminal spikelets, entirely or mostly male, the others female, in the axils. The male spikelets are three to six, stout, crowded, dark brown, acute, with a few female flowers at the base. The anthers have a longer point than in *C. acutiformis*.

*The Author.* FIG. 111.—GREAT POND SEDGE (*Carex riparia*). *See page* 394.

*The Author.* FIG. 112.—CORD-GRASS (*Spartina Townsendi*). *See page* 398.

The glumes are ovate to oblong, acute, slender. The female spikelets are four to six, acute, cylindrical, long, inclined, stalked, sometimes compound below, or male above. The glumes are narrow, brown, with a green midrib, roughish at the tip. The perigynia are ovoid, erect to spreading, dull green, narrowed to the beak, ribbed, longer than the glumes, with many closed ribs. The beak is short with two teeth. The bracts are leaf-like. The fruit is oblong to ovoid, elliptic, convex both sides, three-sided, yellow. There are three stigmas. The nut is pear-shaped, triangular.

This species is 3 to 5 ft. high. It flowers between May and July, and is a herbaceous perennial.

The flowers are wind-pollinated. The stigma ripens in advance of the anthers.

When ripe the nuts may fall in the water and be water-dispersed.

The names of this Sedge are Pond Sedge, Great Common Sedge, Great Sedge.

CAREX RIPARIA.—*Fig.* 111 *gives an idea of the tufted character of the sedges, their social habit; the stems are three-angled, the leaves keeled, the spikelets are large, barren at the top.*

### 89. THE GRASS GROUP.

The Order Graminaceæ is one of the most widespread in the whole realm of plants, not in individuals, but in the universal distribution of the order, grasses forming the most dominant type of vegetation. There are 3600 species and 310 genera. They

are found in all latitudes, and up to high altitudes. Perhaps they may be said to obtain their greatest development in the Temperate regions. In the Tropics the Bamboos attain a great size and height, up to 100 ft.

Grasses are of herbaceous type, except the Bamboo. Some are annual, but the majority are perennial. The latter are branched from the lower nodes, and in this case are tufted. A large number possess rhizomes. The stems have nodes, with hollow internodes, and often root at these points, where the tissue is softer. The nodes when the stems are decumbent may grow again and in this way assume a vertical habit of growth. The stems are cylindrical or compressed, usually hollow. The leaves are often in two rows, alternate, narrow, with parallel veins. They are sheathed at the base, the sheaths split opposite the blade to the base, and end in a ligule or transverse membrane, or in a ring of hairs at the mouth, on the upper side of the leaf. The leaves are, as a rule, without a leaf-stalk. They are generally linear. In order to resist drought the leaves are inrolled, with the stomata protected in the groove thus formed.

The inflorescence is usually a spike, panicle, or raceme. The unit of the inflorescence is a spikelet. Each consists of several alternate, inferior paleæ, or flowering glumes with flowers (up to five) in the axils, and at the base an outer, and an inner, glume, which are empty, enclosing the flowering glumes

above. The flower is primitive. Opposite the inferior palea is a superior palea, or bracteole. There are two lodicules or second bracteoles (there being no perianth) above the superior palea. The flowers are unisexual or complete. The flowering glumes enclose the palea and flower, and are boat-shaped. There are usually three stamens (or one, two, six or more). The anther-stalks are slender and long, and the anthers are versatile, two-celled, pendulous. The ovary is one-celled, with a single carpel. The style may be long or short or wanting. There are two (or one) long, feathery stigmas. The ovule is erect, basal, anatropous. The lodicules are hygroscopic, and force open the paleæ. The fruit is a caryopsis or achene, with pericarp and seed-coat united. Opposite the remains of the style is the embryo. The hilum is on the upper side. The endosperm is floury and abundant. The embryo is straight, outside the endosperm. There is a single cotyledon, or scutellum or sheath, which encloses the plumule, the radical being conical below, swollen above into the scutellum, which surrounds both radicle and plumule. The cotyledon remains within the seed, when germinating, obtaining nutriment from the endosperm.

The flowers are wind-pollinated, and usually the stigma ripens first. The stamens are of rapid growth, and the anthers project out of the paleæ, allowing the pollen to be swept away and caught upon the feathery stigmas.

The fruits are usually light and wind-dispersed.

In this group there are numerous plants of economic importance.

Grasses generally afford pasture for cattle, or hay. The cereals wheat, barley, oats, maize are included. Rice is another important type. The Bamboo is used for a variety of purposes amongst native peoples and in European commerce.

Bentham and Hooker have divided the Graminaceæ into several tribes, a type of each of which is here described.

### Cord-Grass (*Spartina Townsendi*).

In the English name the habit of the plant is referred to. The first Latin name is from the Greek, *spartion*, which is the Greek for Broom. The name is mentioned by Pliny in connection with Broom and also with Sparto Grass, used by paper-makers and others. This was the plant called by Linnæus *Stipa tenacissima*. The name of a British botanist is commemorated in the second Latin name. Another derivation is from the Greek, *spartine*, a cord.

This species is found mainly on the South and East coasts in England, the Isle of Wight, Hants, Sussex, Kent.

Being a maritime species its habitat is mud flats. It forms extensive associations called spartinetum in the salt-marsh formation. It first appeared in 1870, and has spread since then extensively.

The habitat is tufted, the plants forming large tussocks. The stem is stout. The roots are strong and fibrous, with thick stolons spreading horizontally, which serve as sand-binders. The leaves are broadest at the base, stiff, erect, jointed to their sheaths, not so long as the spikes.

The panicle is one-sided, erect, three-angled. The flower consists of four to nine spikelets, with the rachis, which is wavy or flexuous, produced beyond the spikelets. The outer glumes are somewhat downy. The spikelets are somewhat spreading, flattened, stalkless, in two rows. There is a single flower in each spikelet. There are two narrow unequal glumes, the upper five-nerved, longer than the flowering glumes, the lower not so large. There are no lodicules. The stamens are three in number. The ovary is glabrous. The style and stigma are long, the latter hairy. The fruit is enclosed in the palea and flowering glume.

The plant is 1 to 4 ft. high. It is in flower in August, and is a herbaceous perennial.

The flowers are wind-pollinated and the stigmas ripen first.

The caryopsis may be detached and blown away to a distance by the wind.

This species serves the same purpose on muddy coasts that Marram does on sand dunes in helping to bind the sand together, and is thus of economic importance.

SPARTINA TOWNSENDI.—*In Fig.* 112 *the one-sided*

*panicle is shown, the spikelets in two rows, stalkless, flattened, spreading when open.*

FINGERED PANIC GRASS (*Panicum sanguinale*).

As the panicles turn a reddish colour the specific name is rather appropriate. The name Fingered Panic Grass refers to the digitate character of the inflorescence. The name *Panicum* was given by Linnæus, and is derived from *panis*, bread, as the fruit of some species has been used for this purpose.

This is not a common plant in the British Isles, being found in the South of England only as an introduced weed of cultivation.

Waste places, ballast-heaps, etc., form the habitat of this Finger-grass, which occurs with Canary Grass, Maize, Bristle Grass, Wild Oat, etc.

Grass-like in habit, the stems are spreading or creeping below, and become erect or ascending. The leaves are flat, smooth, or hairy, erect. The sheath also is hairy.

The flowers are in a panicle, with two to six slender, simple branches arranged in a digitate manner, spreading from a common centre or nearly so, at the top of the flower-stalk. The spikelets are in pairs on one side, one without stalks, the other shortly-stalked. The first glume is diminutive, the second hollow, half the length of the third, which is more or less flat and five-nerved. The flowering glume is of the same length. There is no awn. The lodicules

*The Author.* FIG. 113.—FINGERED PANIC GRASS (*Panicum sanguinale*). *See page* 400.

*J. H. Crabtree.* FIG. 114.—REED-GRASS (*Phalaris arundinacea*). *See page* 401.

are fleshy, blunt. The fruit is plano-convex, or flattened.

In height the Finger-grass is 6 to 18 in. It flowers in July and August, and is a herbaceous perennial.

The flowers are pollinated by the agency of the wind. The stigma is ripe in advance of the stamens, which are three in number. The stigmas are penicillate, not so long as the styles.

The only names applied to this grass are the ones cited.

Amongst foreign Panic Grasses there are some cereals of value, Indian Millet, an alien in the British Isles, and Samoa Millet. Guinea Grass is a fodder plant. Some of the Panic Grasses are dispersed by animals which feed on them. The stem joints, after passing through the stomach, are able to grow again.

PANICUM SANGUINALE.—*Fig.* 113 *shows the panicle with its five digitate spikes. It is possible to make out the paired spikelets on one side of the rachis, one stalked the other sessile.*

### REED-GRASS OR RIBBON GRASS (*Phalaris arundinacea*).

Familiar in the garden, as the variegated form, this grass is a native plant. The name Ribbon Grass refers to the character of the leaves. The second Latin name indicates its reed-like habit. *Phalaris* is from *phal*, shining.

This species is common in lowland areas in Great Britain as far north as the Shetlands, and in the North of England is found at an altitude of 1400 ft. It is a native of Ireland also, and the Channel Islands.

Rivers, lakes, marshes, watery places generally, form the habitat of Reed-Grass. It is found on limestone, in marshy places, in ashwoods in the fresh-water aquatic formation, in waters relatively rich in mineral salts, in slowly-flowing streams, in the reed-swamp association, in the marsh formation, in the fen formation, as a social species in the closed reed-swamp, and in the valley moors in the reed-swamp association.

The Reed-Grass has the grass habit, being a glabrous plant with stout, erect stems, with spreading branches, creeping below. The leaves are broad and long, the lower ones tufted below. The sheaths are smooth. The ligule is large.

The flowers are in an erect, compact, long panicle, with short roughish branches, spreading when in flower. The spikelets are ovate, purplish or white, numerous. They are not overlapping, nor do they form a spike as in Canary Grass. The outer glumes are lance-shaped, pointed, with no awn, keeled, without a wing, smooth, pale green, three-nerved, with green nerves, and whitish. The flowering glumes are smooth, shining, ovate to lance-shaped, without nerves, silky. The lodicules are two, narrow and silky.

The Reed-Grass is 2 to 5 ft. high, flowering in July and August, and is a herbaceous perennial.

The flowers are wind-pollinated. The stigma ripens slightly in advance of the anthers. At first the plant is pollinated by pollen from an older flower. The flowers live long so that self-pollination may also occur, and the pollen of a younger flower may be transferred to the stigma.

The pseudo-achenes may fall in the water and be dispersed thereby, or be dispersed by the wind.

Several names have been applied to this plant, as Bent, Bride's Laces, Reed Canary Grass, Empy-grass, Floss, Gardener's Garters, Painted Grass, Ribbon Grass, Lady's Laces, Lady's Ribbons, Loch Reed, London Lace, Love's Laces, Reed, Sparked Grass, Spire.

PHALARIS ARUNDINACEA.—*In Fig.* 114 *note the long panicle, which is at first erect and compact, more spreading when the spikelets are expanded; also the sheathing leaves.*

## MARRAM GRASS (*Ammophila arenaria*).

There is a redundance in the two Latin names of this plant, both indicating the sand-loving propensities of Marram. On some parts of the coast this feature is reflected in the local names for sand-dunes or other sandy tracts which are characterised by this grass, such places being frequently termed "the

Marrams," as at Caistor and Blakeney, though at the latter place Marram is not now dominant, but further west at Blakeney Point.

Being a maritime plant it is found only along the coast, where it is frequent as far north as the Shetlands, occurring also in Ireland and the Channel Islands.

Seashores, sand-hills, dunes, are the habitats of Marram Grass. On sand-dunes it is often the dominant plant. It occurs in the sand-dune formation in the Sea Couch-grass association, forming also an association in itself, the Marram or Star-grass association. It also occurs in the shingle beach vegetation.

In habit the Marram is of the Grass type. There is a creeping rootstock which helps to bind the sand together. The stems are erect, stiff, smooth or rough above. The leaves are rigid, bluish-green, long, hollow, the margins inrolled, polished without, rough and bluish-green within, acute. The sheaths are long. The ligule is very long, torn, bifid.

The flowers are in a more or less cylindrical, straight panicle, narrowed into a loose narrow spike, broader, lobed below, yellow. The branches are short. The spikelets are crowded, erect, on rough stalks. The outer glumes are lance-shaped, flattened, acute, with a rough keel, stiff and chaffy. The flowering glumes are shorter, stiff, with a tuft of hairs outside, linear to oblong, three times as long as the hairs, acute. The palea is like the glumes, as

FIG. 115.—MARRAM GRASS (*Ammophila arenaria*).
*Messrs. Flatters and Garnett* (Copyright). *See page* 403.

FIG. 116.—MARRAM (*Ammophila arenaria*).
*Messrs. Flatters and Garnett* (Copyright). *See page* 403.

long, with a small hairy bristle at the base. The yellow anthers are linear.

Marram Grass varies from 1 to 3 ft. in height. Flowers may be found from June to August. It is a herbaceous perennial.

Like other grasses the flowers are wind-pollinated. The stigma ripens before the anthers.

The caryopsis is wind-dispersed or falls near the plant.

Bent, Broad Bent, Helme, Mat-grass, Mat-reed, Signs, Spire and Stare are the English names. Stare-grass is another name. Marram is from the Danish, *Marhalm*, sea haulm or straw.

The Marram is of economic importance in helping to bind the sand together in the case of dunes and to stabilise them, being responsible for the saving of thousands of pounds annually. The creeping stems extend 30 ft. or more.

AMMOPHILA ARENARIA.—*In Fig.* 115 *the habitat is well shown, and also the tufted habit of the grass, with some idea of how it may spread by its long rooting rhizomes. See also Fig.* 116.

FALSE OAT GRASS (*Arrhenatherum avenaceum*).

From the true Oats, of the genus *Avena*, this genus is separated in having the lower flower of each spikelet male only (hence *Arrhenatherum*, from *arrhen*, masculine, and *ather*, awn). In *Avena* there are two to three flowers in the spikelet, the upper one being,

as a rule, imperfect, whereas in Arrhenatherum the lower floret is male, the upper female or hermaphrodite. The second Latin name indicates that the grass resembles the Oat, whilst the English name denotes that the resemblance is not complete.

This grass is one of those that are found in all parts of the British Isles, where, indeed, it is, under the name of Couch Grass, regarded as a pest. In Scotland it is found as far north as the Shetlands. In the north of England it is found at elevations of 1500 feet. It is a native also of the Channel Islands.

Being mainly a pratal species, this grass is found generally in meadows and pastures. It grows also by the wayside, in hedgerows, and even in woods and thickets in the more open spots. It has been found on clays and loams in damp oakwoods, and on similar soils in neutral grassland, on limestone grassland, on chalk grassland.

Like other grasses False Oat Grass has the grass habit. There is an extensive creeping rootstock, which may be knotted, from which the stems grow erect, and are slender and smooth. The leaves are flat, limp, roughish. The sheaths are smooth, and the ligule blunt.

The flowers are arranged in a long, narrow, loose panicle, which is at length close. The branches are binate or ternate, nearly erect, roughish. The spikelets are two-flowered, greenish, shining, pale. The lower empty glume is the smallest, the upper oblong to lance-shaped, acute. The flowering glumes are

*The Author.* Fig. 117.—False Oat Grass (*Arrhenatherum avenaceum*). *See page* 405.

*The Author* Fig. 118.—Dog's-Tooth Grass (*Cynodon Dactylon*). *See page* 407.

nearly stalkless, hairy below the middle, half as long as the awn, which is dark and twisted. The lowest flowering glume has the awn on the middle of the back, and nearly twice as long as the glume, being male only. The upper flowering glume is perfect, and may have a small awn near the top. The lodicules are lance-shaped, with marginal teeth. There are three stamens. The styles are short and distinct. The stigmas are feathery. The caryopsis is downy, and enclosed in the flowering glume and palea.

In height the False Oat Grass is 2 to 3 ft. It flowers from June to July, and is a herbaceous perennial.

As in other grasses the flowers are pollinated by the agency of the wind, the stigmas being adapted for that purpose, being large and feathery.

Likewise the fruit, being light, is adapted to dispersal by the same agency, being readily blown away, as it is loosely enclosed in the glume.

ARRHENATHERUM AVENACEUM.—*Fig.* 117 *shows the loose open panicles and the long bent awn of the two-flowered spikelets.*

### DOG'S-TOOTH GRASS (*Cynodon Dactylon*).

The first Latin name is from the Greek for dog and tooth. The second name refers to the fingered spikes. The plant is abundant in some hot countries, where it is known as Doab Grass or Bermuda Grass, forming pasture.

In the British Isles it is found in the south and west coasts, from Dorset to Cornwall. At Kew

it is a casual. It is found also in the Channel Islands.

Sandy shores form the habitat of this species, but it is also found in waste places, usually near the sea, as a rule in sandy areas.

Grass-like in habit, it is more or less prostrate, creeping and rooting at intervals. The stems are stout, woody, with short, more or less erect, smooth branches, leafy and flowering. The leaves are short, awl-like, downy below, stiff, blunt at the tip, with the margins rolled inwards, as in other halophilous types, to resist physiological drought. They are bluish-green with well-marked veins. The leaves on the prostrate barren shoots are in two rows, flat and spreading. The sheaths are pale, hairy at the mouth.

The flowers are in a short panicle, and the spikes are three to five, slender, digitate, radiating from a common centre, purplish in colour. The rachis is convex with a groove above. The spikelets are overlapping, purplish. The empty glumes are narrow, ovate, acute, nearly equal, open. The keel is roughish. The flowering glumes are longer, hardened in fruit, smooth at the margin, rough on the keel and edges, three-nerved, awnless. The palea is two-nerved, narrow. The lodicules are fleshy and blunt. There are three stamens. The ovary is smooth. The two styles are long with feathery stigmas. The caryopsis is flattened at the border, enclosed in the flowering glume and palea.

In height the Dog's-Tooth Grass is 4 to 8 in. It

flowers in July and August, and is a herbaceous perennial.

Wind is the agent which brings about pollination, the stigmas being adapted to that end.

The caryopsis may be wind-dispersed.

Dog's-Tooth Grass, Doab Grass, Bermuda Grass, are the only names this plant has received.

As mentioned it serves in some regions as a useful pasture grass, though littoral in this country.

CYNODON DACTYLON.—*In Fig.* 118 *note the flat, spreading leaves of the barren shoots, the shorter stem-leaves, and the panicle with its digitate spikes, radiating from a common centre.*

### COCK'S-FOOT GRASS (*Dactylis glomerata*).

In the first Latin name is indicated the finger-like character of the panicle when expanded, and in the second the somewhat compact character of the component spikelets. The shape of the inflorescence is somewhat like a cock's foot, hence the English name.

Widespread in this country, this grass is a valuable pasture and meadow grass and occurs in all parts of the British Isles, northward to the Shetland Isles. In the north of England it ascends to an altitude of 1600 ft. It is found in Ireland and the Channel Islands.

Meadows, pastures, waste places, railway banks, woods, form the habitat of the plant. It is found on

clay and loam in damp oakwoods, in neutral grass-land on chalk in chalk grass-land.

This rather coarse plant has the normal grass habit. The stems are creeping below, erect, stout, smooth, tufted. The whole plant is roughish. The leaves are broad, flat, linear, limp, rough at the margin, with roughish keels. The ligule is long.

The flowers are in a rigid panicle, which is green and violet. The lower branches are few, long, rigid, roughish, in flower spreading or horizontal, erect in fruit. The branches form dense ovate clusters with the panicle, and may be reduced to one cluster. The branches are usually spreading and the flowers distant. The spikelets are ovate, oblong, rough, flattened, and three- to five- flowered. The glumes are lance-shaped with a well-marked keel, with a fringe of hairs on the back, acute above. The empty glumes are two, membranous. The flowering glumes are more pointed, sometimes awned, and are five-nerved. The lodicules are feathery. There are three stamens. The caryopsis is flattened one side, grooved the other, enclosed in the glume.

In height the Cock's-Foot Grass may be 1 to 4 ft. It flowers from June to September, and is a herbaceous perennial.

Pollination is effected by aid of the wind. The stigmas ripen a little in advance of the anthers. The stigma is long-lived. Unlike other grasses the anthers do not turn down. The flowers open between 6 and 9 a.m.

*J. H. Crabtree.* FIG. 119.—COCK'S-FOOT GRASS (*Dactylis glomerata*). *See page* 409.

FIG. 120.—MAT-GRASS (*Nardus stricta*).
*Messrs. Flatters and Garnett* (Copyright). *See page* 411.

Britten and Holland cite the following names for this plant, Bull Faces, Cock Foot, Cock's Foot, Cock's-Foot Grass, Deco-grass, Dog Foot, Fox's Foot, Cow's Grass, Rough Grass, Sticky Grass, Hard Grass, Orchard Grass.

DACTYLIS GLOMERATA.—*The illustration (Fig.* 119) *shows the rigid panicle, with few lower branches. In flower these are seen to be more expanded. The lower flowers have anthers projecting.*

MAT-GRASS (*Nardus stricta*).

Though this plant, placed in the Genus Nardus,—a name applied by Theophrastus, which signifies a plant from the flower of which a sweet fragrant oil was obtained—is so-called, it is quite inappropriate. The second Latin name refers to the rigid character of the panicle and leaves. Mat-grass also indicates the matted habit.

In certain habitats this grass is not uncommon in Britain, but more confined to North Britain, and the west of England, extending as far north as the Shetlands. It occurs at over 3000 ft. in the Highlands. It is found in Ireland and the Channel Islands.

Moors, heaths, dry hilly pastures form the habitat of this grass. It is found on sandy soil on heaths, on wet heaths, on *Calluna* heaths, on moist humous soils, on siliceous soils in the sessile oakwood, in siliceous grass-land, forming in itself an association of grass-land, with Purple Moor-grass on upland

moors on Bilberry moors, on Heather moors, in Grass moor associations forming a typical facies in arctic-alpine vegetation, in the closed moorland association, etc.

Mat Grass has the typical grass habit, and is closely-tufted. The rootstock is stout and creeping. The stems are erect, slender, rigid, furrowed, angled, wiry. There are long pale sheaths below. The leaves are fine, bristle-like, channelled, roughish, stiff, the upper erect, the lower spreading or squarrose. The sheaths are smooth. The ligule is short.

The panicle is unilateral, one-sided, slender, close, solitary, simple, purplish. The rachis is slender, rigid. The spikelets are distant, one-flowered, stalkless, alternate, in two rows. The flowering glume is slender, red or purple, spreading after flowering, rough above, narrowed into a short rough awn. The lower palea is awned, the upper membranous. There are three stamens and a simple style.

In height Mat Grass is 2 to 8 in. It flowers from June to August, and is a herbaceous perennial.

The flowers are wind-pollinated. The stigma ripens before the anthers. The spikelets open at the tip for the stamens and the style to project.

The caryopsis is dispersed by the wind.

Mat Grass is called Black Bent, White Bent, Wire Bent, Ling, Mat-weed, Nard.

NARDUS STRICTA.—*In the illustration* (*Fig.* 120) *are two plants showing the tufted habit, the long bristle-like leaves, and the one-sided panicle.*

# APPENDIX I

Since the system of Engler and Prantl ('Syllabus der Pflanzen familien,' ed. vii, 1912) is coming into somewhat greater vogue in this country, having been long in use on the Continent and in America, we give a summary of it here, with reference to the pages where the orders are described in the three volumes. The order is that of the 'Genera of British Plants,' by Dr. H. G. Carter, which contains some modifications made by Dr. C. E. Moss.

The characters of the orders are taken from Engler in the main; those of the sub-orders from Dr. Carter's synopsis; those of the families from other sources. It is not possible to give within the limits of space allowed diagnoses of the numerous genera, of which there are some five hundred in the British flora alone. Reference should be made to such systematic works as those of Hooker, Bentham and Hooker, Babington, or other standard British works.

For purposes of identification, the use of dichotomous keys to orders, families, genera, etc., may be recommended, such as those in Bentham and Hooker's 'Handbook of the British Flora,' in which also keys to species will also be found under each genus.

For ready reference, and convenient for the pocket, are Druce's 'Botanist's Pocket-book' and the less comprehensive Watts' 'School Flora.'

## SYNOPSIS OF ORDERS, GENERA, ETC.

### DIVISION. EMBRYOPHYTA SIPHONOGAMA (= PHANEROGAMIA).

(Introductory Vol., p. 32; Vol. II, p. 58.)

Alternation of generations obscured by seed formation: sporophyte cormophytic, heterosporous.

Megaspore (embryo-sac) not discharged from sporangium (ovule); the latter when fertilised forms a seed.

Microspore (pollen-grain) on germinating forms a pollen-tube. Antheridium a single cell dividing to form the two generative cells.

### SUB-DIVISION. ANGIOSPERMÆ. (Introductory Vol., p. 32; Vol. II, p. 58.)

Ovules produced in an ovary formed of coherent carpels, or of one carpel with coherent margins; endosperm formed after fertilisation; stigma formed.

### CLASS I. MONOCOTYLEDONS.

(Introductory Vol., p. 197; Vol. III, p. 269.)

Embryo with one cotyledon; stem with closed vascular bundles (scattered in cross-section); leaves usually parallel-veined; flowers usually trimerous.

A.—*Orders with predominating Inconstancy in the Number of Floral Leaves.*

ORDER 1. PANDANALES.—Flowers naked or with homochlamydeous, bract-like perianth, unisexual; stamens 1 to many; carpels 1 to many; endosperm present; inflorescence compound, spherical or cylindrical.

Family 1. Typhaceæ (Vol. III, p. 347).—Plant monœcious; male flowers above, hermaphrodite below, spadix cylindrical; no spathe; perianth of scales or hairs; triandrous ovary 1–2 locular; style persistent.

*Genus.* *Typha* (Vol. III, p. 350.)

Family 2. Sparganiaceæ. (By some united with the last.) Inflorescence globose; lower inflorescence hermaphrodite; upper male.

*Genus.* *Sparganium* (Vol. III, p. 348).

ORDER 2. ALISMATALES (Fluviales, Helobieæ).—Flowers cyclic or hemicyclic; perianth wanting or in 1 or 2 whorls; homo- or heterochlamydeous, hypogynous, or epigynous; stamens 1 to many; carpels 1 to many; apo- or syncarpous; endosperm little or none.

SUB-ORDER 1. POTAMOGETONINEÆ. — Flowers hypogynous, achlamydeous, or haplo- to homochlamydeous.

Family 1. Potamogetonaceæ.—Flowers solitary or in spikes, with parts of the flowers in whorls of 4–1; achlamydeous as a rule; stamens 4–1; carpels 4–1; ovule pendulous.

*Tribe* 1. *Zostereæ.*

*Genus.* *Zostera* (Vol. III, p. 383).

*Tribe* 2. *Potamogetoneæ.*

*Genera.* *Potamogeton* (Vol. III, p. 378), *Ruppia.*

*Tribe* 3. *Zannichellieæ.*

*Genus. Zannichellia* (Vol. III, p. 381).

Family 2. Naiadaceæ (Vol. III, p. 374).—Flowers uni- or bisexual; plant monœcious or diœcious; male flowers with two envelopes and terminal anther; female with one (or no) envelope and one carpel, with one ovule.

*Genus. Naias* (Vol. III, p. 385).

Family 4. Scheuchzeriaceæ (Juncaginaceæ).—Plants scapigerous; inflorescence racemose; flowers monoclinous or diclinous, parts 4–1; perianth homochlamydeous; carpels with 1–2 ovules (anatropous).

*Tribe. Triglochineæ.*

*Genera. Triglochin* (Vol. III, p. 376), *Scheuchzeria.*

SUB-ORDER 2. ALISMATINEÆ.—Flowers hypogynous, heterochlamydeous; ovules on ventral suture.

Family 5. Alismataceæ.—Inflorescence branched; flowers generally monoclinous, heterochlamydeous, parts in threes; stamens 3 to many; carpels 6 to many; styles 6 to many.

*Genera. Alisma* (Vol. III, p. 370), *Elisma, Damasonium, Echinodorus, Sagittaria* (Vol. III, p. 372).

SUB-ORDER 3. BUTOMINEÆ.—Flowers hypogynous, epigynous, heterochlamydeous.

Family 6. Butomaceæ.—Inflorescence cymose or umbellate; plant monœcious, flowers heterochlamydeous, parts in threes; carpels (6 to many).

*Genus. Butomus.*

Family 7. Hydrocharitaceæ (Vol. III, p. 278).—Flowers unisexual, cymose or solitary, regular, usually diclinous, heterochlamydeous as a rule, parts in threes.

Sub-Family 1. Stratiotoideæ.

*Tribe* 1. *Stratioteæ.*

*Genus. Stratiotes* (Vol. III, p. 285).

*Tribe* 2. *Hydrochariteæ.*

*Genus. Hydrocharis* (Vol. III, p. 280).

Sub-Family 2. Vallisnerioideæ.

*Tribe. Hydrilleæ.*

*Genus. Elodea* (Vol. III, p. 282). *Hydrilla.*

ORDER 3. GLUMIFLORÆ.—Flowers naked, rarely with hair-like or true perianth, covered by glumes; ovary unilocular, with one ovule.

Family 1. Graminaceæ (Vol. III, p. 395).—Flowers usually bisexual (plant monœcious as a rule), with axillary sessile spikelets, triandrous; anthers versatile; ovary unilocular; stigmas 2, feathery, sessile; ovules 2; fruit a pseudo-achene or caryopsis; endosperm abundant.

Sub-Family 1. Panicoideæ.

*Tribe* 1. *Paniceæ.*

*Genera. Panicum* (Vol. III, p. 400), *Setaria.*

*Tribe* 2. *Oryzeæ.*

*Genus. Leersia.*

Sub-Family 2. Poëoideæ.

*Tribe* 3. *Phalarideæ.*

*Genera. Phalaris* (Vol. III, p. 401), *Anthoxanthum, Hierochlöe.*

*Tribe* 4. *Agrostideæ.*

*Genera. Milium, Alopecurus, Phleum, Mibora, Agrostis, Polypogon, Calamagrostis, Gastridium, Apera, Deyeuxia, Ammophila* (Vol. III, p. 403), *Lagurus.*

*Tribe* 5. *Aveneæ.*

*Genera. Holcus, Aira, Corynephorus, Deschampsia, Trisetum, Avena, Arrhenatherum* (Vol. III, p. 405).

*Tribe* 6. *Festuceæ.*

*Genera. Sieglingia, Phragmites, Sesleria, Cynosurus, Kœleria, Molinia, Catabrosa, Melica, Dactylis* (Vol. III, p. 409), *Briza, Poa, Glyceria, Festuca, Bromus, Brachypodium.*

*Tribe* 7. *Chlorideæ.*

*Genera.* *Spartina* (Vol. III, p. 398), *Cynodon* (Vol. III p. 407).

*Tribe* 8. *Hordeæ.*

*Genera.* *Nardus* (Vol. III, p. 411), *Lolium*, *Lepturus*, *Triticum*, *Hordeum*, *Elymus.*

Family 2. Cyperaceæ (Introductory Vol., p. 215; Vol. III, p. 388).—Flowers uni- or bisexual, cymose, with axillary spikelets; perianth wanting, or of 3–6 bristles; stamens 1–3; anthers basifixed; ovary 2–3–locular; stigmas 2–3; fruit a capsule, or achene, with free seed.

Sub-Family 1. Scirpoideæ.

*Tribe* 1. *Scirpeæ.*

*Sub-Tribe* 1. *Cyperinæ.*

*Genus.* *Cyperus.*

*Sub-Tribe* 2. *Scirpinæ.*

*Genera.* *Heleocharis*, *Scirpus*, *Eriophorum* (Introductory Vol., p. 217).

Sub-Family 2. Rhynchosporoideæ.

*Tribe* 2. *Rhynchosporeæ.*

*Genera.* *Rhynchospora*, *Schœnus* (Vol. III, p. 390), *Cladium.*

Sub-Family 3. Caricoideæ.

*Genera.* *Kobresia* (Vol. III, p. 392), *Carex* (Vol. III, p. 394).

ORDER 4. SPATHIFLORÆ.—Flowers cyclic, with 0, 1 or 2 whorls in the perianth, the parts in threes or twos, hermaphrodite or unisexual, often much reduced, even to 1 stamen or carpel; spadices simple, enclosed in spathes, with no bracts.

Family 1. Araceæ (Vol. III, p. 354).—Flowers uni- or bi-sexual, plants rarely diœcious, or spadix enclosed in a spathe; parts of flower 2–3; perianth 6 scale-like seg-

ments or none; stamens 6 or less (1); ovary 1 or 2–3-locular; style persistent.

Sub-Family 1. Pothoideæ.

*Tribe* 1. *Acoreæ.*

*Genus. Acorus* (Vol. III, p. 361).

Sub-Family 2. Aroideæ.

*Tribe* 2. *Areæ.*

*Genus. Arum* (Vol. III, p. 356).

Family 2. Lemnaceæ (Vol. III, p. 363).—Flowers unisexual, plant monœcious. Inflorescence of 2 male flowers and 1 female flower in reduced spathe, male flower of 1 stamen, female of 1 carpel.

Sub-Family 1. Lemnoideæ.

*Genera. Spirodela, Lemna* (Vol. III, p. 364).

Sub-Family 2. Wolffoideæ.

*Genus. Wolffia* (Vol. III. p. 366).

### B.—*Orders with Typically Pentacyclic Flowers. Whorls Typically Isomerous, mostly 3-Merous.*

ORDER 5. FARINOSÆ.—Flowers homo- or heterochlamydeous, 3- or 2-merous, perianth usually 3 + 3, stamens 3 + 3, gynœcium (3), one whorl of stamens may be wanting, or all the stamens but 1; ovules often orthotropous; endosperm mealy.

Family. Eriocaulaceæ (Vol. III, p. 344).—Flowers inconspicuous, unisexual, in involucrate heads; plant usually monœcious; perianth of scales, or in 2 whorls (3 + 3); stamens 4 or 6; ovary 2–3-locular; stigmas 2–3; fruit a capsule.

Sub-Family. Eriocauloideæ.

*Genus. Eriocaulon* (Vol. III, p. 344).

ORDER 6. LILIIFLORÆ.—Similar to the last, but

the endosperm is fleshy or cartilaginous; ovules anatropous as a rule; parts of flowers sometimes 4 or 5.

SUB-ORDER I. JUNCINEÆ.—Perianth homochlamydeous, not petaloid, endosperm containing starch.

Family I. Juncaceæ (Vol. III, p. 338).—Flowers bisexual, homochlamydeous, parts in threes; perianth bract-like, 6-partite, sepaloid; ovary I or 3-locular; style I; fruit a capsule or berry.

*Genera. Juncus* (Introductory Vol., p. 213), *Luzula* (Vol. III, p. 340).

SUB-ORDER 2. LILIINEÆ.—Perianth petaloid as a rule, homo- to heterochlamydeous, inner ring of stamens present; endosperm not starchy.

Family 2. Liliaceæ. — Flowers bi-sexual, homochlamydeous as a rule; perianth petaloid, 6-partite, segments free or united, stamens usually 6; ovary superior, 3-locular; fruit a capsule or berry.

Sub-Family I. Melanthioideæ.

*Tribe* I. *Tofieldieæ.*

*Genera. Narthecium* (Vol. III, p. 334), *Tofieldia.*

*Tribe* 2. *Colchiceæ.*

*Genus. Colchicum* (Introductory Vol., p. 207).

Sub-Family 2. Asphodeloideæ.

*Genus. Simethis* (Vol. III, p. 325)

Sub-Family 3. Allioideæ.

*Tribe* 3. *Allieæ.*

*Genera. Gagea, Allium* (Vol. III, p. 327).

Sub-Family 4. Lilioideæ.

*Tribe* 4. *Tulipeæ.*

*Genera. Lilium, Fritillaria* (Vol. III, p. 332), *Tulipa, Lloydia.*

*Tribe* 5. *Scilleæ.*

*Genera. Scilla* (Vol. III, p. 328), *Ornithogalum, Muscari.*

Sub-Family 5. Asparagoideæ.

*Tribe* 6. *Asparageæ.*

*Genera. Asparagus, Ruscus* (Vol. III, p. 319).

*Tribe* 7. *Polygonateæ.*

*Genera. Polygonatum, Maianthemum.*

*Tribe* 8. *Convallarieæ.*

*Sub-Tribe. Convallariinæ.*

*Genus. Convallaria* (Vol. III, p. 322).

*Tribe* 9. *Parideæ.*

*Genus. Paris* (Vol. III, p. 336.)

Family 3. Amaryllidaceæ (Vol. III, p. 303).—Flowers usually bisexual; perianth 6-partite, inner series (or both) petaloid; anthers mainly introrse; stamens 6 or more; carpels numerous, apocarpous; ovary usually inferior; ovules anatropous; fruit a capsule or berry.

Sub-Family 1. Amaryllidoideæ.

*Tribe* 1. *Amaryllideæ.*

*Genera. Leucojum* (Vol. III, p. 313), *Galanthus* (Vol. III, p. 309).

*Tribe* 2. *Narcisseæ.*

*Sub-Tribe. Narcissinæ.*

*Genus. Narcissus* (Vol. III, p. 305).

Family 4. Dioscoreaceæ. (Introductory Vol., p. 209; Vol. III, p. 314.)—Flowers unisexual, inflorescence racemose, homochlamydeous; perianth, small, sepaloid, 6-partite; stamens 6; ovary 3-locular; fruit a berry or capsule.

*Tribe. Dioscoreæ.*

*Genus. Tamus* (Introductory Vol., p. 210).

SUB-ORDER 3. IRIDINEÆ.—Like Liliinæ, but the inner whorl of stamens is functionless.

Family 5. Iridaceæ (Introductory Vol., p. 202; Vol. III, p. 298).—Flowers bisexual, homo- or heterochlamydeous, regular or irregular, trimerous; stamens 3;

anthers extrorse; ovary 3-locular; numerous ovules on axile placentæ; stigmas 3; fruit a capsule.

Sub-Family 1. Crocoideæ.

*Genera.* *Romulea, Crocus* (Vol. III, p. 299).

Sub-Family 2. Iridoideæ.

*Tribe* 1. *Moraeeæ.*

*Genus.* *Iris* (Introductory Vol., p. 204).

*Tribe* 2. *Sisyrinchieæ.*

*Genus.* *Sisyrinchium.*

Sub-Family 3. Ixioideæ.

*Tribe.* *Gladioleæ.*

*Genus.* *Gladiolus* (Vol. III, p. 301).

ORDER 7. MICROSPERMÆ (Vol. III, p. 277).—Flowers cyclic, homo- or heterochlamydeous, typically diplostemonous, but often with important reduction; ovary inferior, tri- or uni-locular; with numerous small ovules; endosperm or none.

SUB-ORDER. GYNANDRÆ.—Flowers always irregular, no endosperm.

Family. Orchidaceæ (Introductory Vol., p. 198; Vol. III, p. 287).—Flowers bisexual, irregular; stamens gynandrous 1 or 2; ovary unilocular; ovules numerous, on 3 parietal placentæ; fruit a capsule.

Sub-Family 1. Pleonandræ (Diandræ).

*Tribe* 1. *Cypripedileæ.*

*Genus.* *Cypripedium* (Vol. III, p. 295.)

Sub-Family 2. Monandræ.

*Tribe* 2. *Ophrydeæ.*

*Sub-Tribe.* *Serapiadinæ.*

*Genera.* *Orchis* (Introductory Vol., p. 201), *Aceras, Ophrys.*

*Sub-Tribe.* *Gymnadeniinæ.*

*Genera.* *Herminium, Habenaria.*

*Tribe* 3. *Neottieæ.*

*Sub-Tribe* 1. *Cephalantherinæ.*

*Genera.* *Epipactis, Cephalanthera, Epipogon.*

*Sub-Tribe* 2. *Spiranthinæ.*

*Genera.* *Spiranthes, Listera* (Vol. III, 293), *Neottia.*

*Sub-Tribe* 3. *Phvsurinæ.*

*Genus.* *Goodyera.*

*Tribe* 4. *Liparidieæ.*

*Genera.* *Malaxis* (Vol. III, p. 291), *Liparis, Corallorhiza.*

CLASS II. DICOTYLEDONS. (Introductory Vol., p. 32; Vol. II, p. 58.)

Embryo usually with 2 cotyledons; stem with open vascular bundles, usually in a single ring; leaves usually net-veined; flowers with parts in fours or fives as a rule, or in twos.

SUB-CLASS I. ARCHICHLAMYDEÆ.

Perianth in lower stages of development, *i.e.* either (1) absent, (2) simple, in one whorl, petaloid or sepaloid; (3) in two whorls, the inner polyphyllous; (4) in two whorls, the inner gamophyllous, or (5) in one whorl, in consequence of abortion of the inner whorls.

A. AMENTIFLORÆ.—*Male flowers usually, and female flowers often, in catkins; perianth absent or haplochlamydeous and bracteoid.*

ORDER I. SALICALES.—Flowers naked, plant diœcious, with cup-like disc, sometimes reduced to tooth-like scales; stamens 2 to many; carpels (2); gynœcium 1-locular, with numerous anatropous ovules on parietal placentæ; capsule, with numerous

seeds; seed small, exalbuminous, with basal tuft of hairs.

Family. Salicaceæ (Vol. III, p. 259). — Plants diœcious, bracts simple; perianth wanting; stamens 2 or more; ovary superior, 1-locular; ovules numerous, parietal; fruit a capsule.

*Genera. Populus* (Vol. III, p. 261), *Salix* (Introductory Vol., p. 192).

ORDER 2. MYRICALES.—Flowers achlamydeous; plants monœcious or diœcious; flowers with bracteoles at the base; stamens 4 as a rule; carpels (2); ovary 1-locular; ovule 1, orthotropous; styles 2; fruit a drupe.

Family. Myricaceæ (Vol. III, p. 250).—Flowers unisexual, in short erect catkins; bracts overlapping; perianth wanting; stamens 2–16; ovary 1-locular; ovule 1, erect.

*Genus. Myrica* (Vol. III, p. 251).

ORDER 4. FAGALES.—Flowers cyclic, in simple or compound spikes, homochlamydeous, rarely naked, generally unisexual; plants monœcious; stamens often anteposed to perianth-leaves; carpels (2–6), each with 1–2 ovules; gynœcium superior; fruit usually nut-like, 1-seeded; no endosperm.

Family 1. Betulaceæ.—Flowers before leaves; perianth present in flowers of only one sex; male catkins compound, united to bracts; stamens 2–10; carpels (2); styles 2.

*Tribe* 1. *Corvleæ.*

*Genera. Carpinus, Corylus* (Vol. III, p. 255).

*Tribe* 2. *Betuleæ.*

*Genera. Betula* (Introductory Vol., p. 195), *Alnus* (Introductory Vol., p. 189).

Family 2. Fagaceæ.—Flowers and leaves together, or former first; perianth 4–7–partite; male catkins simple or compound; stamens 4–14; carpels 3–4; styles 3–4; fruit with cupule.

*Tribe* 1. *Fageæ.*

*Genus.* *Fagus* (Introductory Vol., p. 190).

*Tribe* 2. *Castaneæ.*

*Genera.* *Castanea*, *Quercus* (Introductory Vol., p. 187).

ORDER 5. URTICALES.—Flowers cyclic, in cymose panicles, homochlamydeous, rarely naked, usually 2-merous, rarely 2 + 3, generally regular; stamens anteposed to perianth-leaves; carpels 2–1; gynœcium superior, with 1 ovule; fruit a nut.

Family 1. Ulmaceæ (Introductory Vol., p. 180).—Flowers usually bisexual; perianth 4–5–partite; stamens, 4–5; carpels (2); styles 2; fruit a nut or drupe.

Sub-Family. Ulmoideæ.

*Genus.* *Ulmus* (Introductory Vol., p. 182).

Family 2. Cannabaceæ. — Plant diœcious; male flowers, perianth 5-partite; stamens 5; female flowers with cup-like perianth; carpels 2; styles 2; ovule pendulous; fruit a nut.

*Genera.* *Humulus* (Vol. III, p. 247), *Cannabis.*

Family 3. Urticaceæ (Introductory Vol., p. 176; Vol. III, p. 245).—Flowers unisexual; perianth 4–5–partite; stamens incurved in bud; ovary 1-locular; ovule 1; fruit an achene or nut.

*Tribe* 1. *Urticeæ.*

*Genus.* *Urtica* (Introductory Vol., p. 177)

*Tribe* 2. *Parietariceæ.*

*Genus.* *Parietaria.*

B. PETALOIDEÆ.—*Flowers haplochlamydeous; perianth often petaloid. Diplochlamydeous flowers rare* (*Rumex*).

ORDER 6. SANTALALES.—Flowers cyclic, homochlamydeous, with stamens anteposed to perianth-leaves, rarely heterochlamydeous, haplo- or diplostemonous; gynœcium superior (2–3, rarely 1), each carpel with one ovule, pendulous from apex of loculi or from free-central placenta; sometimes—in Loranthaceæ—the ovules and placenta are not differentiated, but the embryo-sacs are in the tissue filling the interior of the ovary.

SUB-ORDER 1. SANTALINEÆ.—Ovules differentiated from placenta, often without integument.

Family. Santalaceæ (Vol. III, p. 229).—Flowers bisexual; perianth 5-partite, persistent, bracteoid or petaloid; stamens 5; ovary 1-locular; ovules 1–3, on free central placenta.

*Tribe. Thesieæ.*

*Genus. Thesium* (Vol. III, p. 231).

SUB-ORDER 2. LORANTHINEÆ. — Ovules mostly not differentiated.

Family. Loranthaceæ (Vol. III, p. 223).—Flowers unisexual, small, green; perianth 4-partite; stamens fused to perianth-lobes; ovary 1-locular; fruit a pseudo-berry.

Sub-Family. Viscoideæ.

*Tribe. Visceæ.*

*Genus. Viscum* (Vol. III, p. 225).

ORDER 7. ARISTOLOCHIALES. — Flowers cyclic, homochlamydeous, epigynous, regular, or zygomorphic; perianth petaloid; ovary usually inferior,

4–6–locular, with axile, or 1-locular with parietal, placentæ and numerous ovules.

Family. Aristolochiaceæ (Vol. III, p. 212).—Flowers bisexual, actinomorphic, or irregular; perianth superior, petaloid, 3-partite, trumpet-like, or lobed; stamens 6 or 12; ovary 6-locular; ovules numerous; fruit a capsule.

*Tribe* 1. *Asareæ.*

*Genus. Asarum* (Vol. III, p. 213).

*Tribe* 2. *Aristolochieæ.*

*Genus. Aristolochia.*

ORDER 8. POLYGONALES. — Flowers homo- or heterochlamydeous, regular; ovary superior, 1-locular, with 1 erect, rarely anatropous ovule; leaves usually with ocreate stipules.

Family. Polygonaceæ (Vol. III, p. 206).—Flowers usually bisexual, inflorescence compound, cyclic, or sub-spiral; perianth 3 to 6-partite, green, or red, persistent after flowering; stamens 5–9; ovary 1-locular; ovule 1, erect; styles 3; fruit a triangular nut.

Sub-Family 1. Rumicoideæ.

*Tribe. Rumiceæ.*

*Genera. Rumex* (Vol. III, p. 210), *Rheum.*

Sub-Family 2. Polygonoideæ.

*Tribe. Polygoneæ.*

*Genus. Polygonum* (Vol. III, p. 208).

c. *Corolla usually haplochlamydeous, sepaloid or petaloid. Heterochlamydy, however, is not uncommon.*

ORDER 9. CENTROSPERMÆ.—Flowers acyclic or cyclic, homo- or heterochlamydeous; stamens often as many as, and opposite to, the perianth-leaves, but also numerous to 1; carpels, 1 to numerous, usually

united; ovary superior, rarely multilocular, generally 1-locular, with 1 to numerous campylotropous ovules; perisperm; embryo curved; mostly herbs.

SUB-ORDER 1. CHENOPODINEÆ.—Perianth homochlamydeous, sepaloid, 5-partite; stamens 5, opposite; ovule solitary.

Family 1. Chenopodiaceæ (Vol. III, p. 194).—Flowers uni- or bisexual, homochlamydeous; perianth 3 to 5-partite, persistent after flowering; stamens 5 or 3, bent inwards in bud; ovary 1-locular; ovule 1, basal; stigmas usually 2; fruit a nutlet or pyxidium, indehiscent.

(*a*) Cyclolobeæ.

*Tribe* 1. *Beteæ.*

*Genus. Beta.*

*Tribe* 2. *Chenopodieæ.*

*Genus. Chenopodium* (Vol. III, p. 196).

*Tribe* 3. *Atripliceæ.*

*Genus. Atriplex* (Vol. III, p. 198).

*Tribe* 4. *Salicornieæ.*

*Genus. Salicornia* (Vol. III, p. 200).

(*b*) Spirolobeæ.

*Tribe* 5. *Suædeæ.*

*Genus. Suæda* (Vol. III, p. 202).

*Tribe* 6. *Salsoleæ.*

*Genus. Salsola* (Vol. III, p. 204).

Family 2. Amarantaceæ.—Flowers unisexual; perianth 3–5–partite; stamens 3–5, opposite, persistent; ovary 1-locular; ovule 1; stigmas 3.

*Genus. Amarantus.*

SUB-ORDER 2. PHYTOLACCINEÆ.—Flowers haplo- or heterochlamydeous, with a tendency to spiral arrangement; stamens sometimes numerous; carpels sometimes only slightly united.

Family 3. Aizoaceæ.—Flowers usually haplochlamydeous; stamens 5 or more; carpels (2 to many); ovary 2 to many-locular.

*Tribe. Mesembryanthemeæ.*

*Genus. Mesembryanthemum.*

SUB-ORDER 3. PORTULACINEÆ.—Flowers heterochlamydeous; sepals 2; petals 4–5.

Family 4. Portulaceaæ (Vol. II, p. 135).—Flowers regular; sepals 2; petals 5, free or united below; stamens 3–5; ovary syncarpous, 1-locular; ovules 3, on a central basal placenta; styles 3; fruit a 3-valved capsule.

*Genera. Claytonia, Montia* (Vol. II, p. 137), *Portulaca.*

SUB-ORDER 4. CARYOPHYLLINEÆ.—Flowers heterochlamydeous, with sepals and petals equal, cyclic, sometimes apopetalous.

Family 5. Caryophyllaceæ (Introductory Vol., p. 65; Vol. II, p. 128).—Flowers regular, in dichasia, cyclic, usually heterochlamydeous; sepals and petals 4–5; stamens 8–10, usually in 2 whorls; ovary syncarpous, 1-locular; ovules on a central placenta; styles 2–5; fruit a capsule opening by apical teeth.

Sub-Family 1. Alsinoideæ.

*Tribe* 1. *Alsineæ.*

*Genera. Stellaria* (Introductory Vol., p. 67), *Cerastium* (Vol. II, p 133), *Holosteum, Arenaria, Sagina.*

*Tribe* 2. *Sperguleæ.*

*Genera. Spergula, Spergularia.*

*Tribe* 3. *Polycarpeæ.*

*Genus. Polycarpon.*

*Tribe* 4. *Paronychieæ.*

*Genera. Corrigiola, Herniaria, Illecebrum.*

*Tribe* 5. *Scleruntheæ.*

*Genus. Scleranthus* (Vol. III, p. 192).

Sub-Family 2. Silenoideæ.

*Tribe* 6. *Lychnideæ.*

*Genera. Agrostemma, Viscaria, Silene, Lychnis* (Vol. II, p. 130), *Melandryum, Cucubalus.*

*Tribe* 7. *Diantheæ.*

*Genera. Dianthus, Saponaria.*

D. HETEROCHLAMYDEÆ, *with predominant heterochlamydy.*

ORDER 10. RANALES.—Flowers spiral to cyclic, regular or not, haplo- to heterochlamydeous, epi- to hypogynous, usually with numerous stamens; carpels numerous to one, usually free, rarely united.

SUB-ORDER 1. NYMPHÆINEÆ.—Flowers spiral as a rule; ovules scattered over inner surface of carpels, but sometimes solitary at the apex.

Family 1. Nymphæaceæ (Introductory Vol., p. 49; Vol. II, p. 79).—Flowers regular, solitary, bi-sexual, homo- to heterochlamydeous; receptacle convex or hollow and united to gynœcium; sepals 4–5; petals and stamens indefinite; ovary syncarpous, 10–20-locular; ovules numerous, with 2 integuments.

Sub-Family. Nymphæoideæ.

*Tribe* 1. *Nuphareæ.*

*Genus. Nuphar.*

*Tribe* 2. *Tetrasepaleæ.*

*Genus. Nymphæa* (Introductory Vol., p. 51).

Family 2. Ceratophyllaceæ (Vol. III, p. 262).—Flowers solitary, axillary, haplochlamydeous, unisexual; perianth 6–12-partite; stamens 6–12; carpel 1; ovule 1.

*Genus. Ceratophyllum* (Vol. III, p. 264).

Sub-Order 2. Ranunculineæ.—Flowers spiral to cyclic; ovules on ventral suture.

Family 3. Ranunculaceæ (Introductory Vol., p. 34; Vol. II, p. 65).—Flowers regular, rarely zygomorphic, haplo- to heterochlamydeous, bisexual; sepals often petaloid; petals often none (*Caltha*); stamens many, free; carpels many, apocarpous, free; ovules many to 1; fruit an aggregate of achenes or follicles, a berry.

*Tribe* 1. *Pæonieæ.*

*Genus. Pæonia.*

*Tribe* 2. *Helleboreæ.*

*Genus. Caltha* (Introductory Vol., p. 47), *Trollius, Eranthis, Helleborus, Actæa, Aquilegia, Delphinium, Aconitum.*

*Tribe* 3. *Anemoneæ.*

*Genera. Clematis* (Vol. II, p. 69), *Thalictrum, Anemone* (Introductory Vol., p. 37), *Adonis, Myosurus, Ranunculus* (Introductory Vol., p. 40).

Family 4. Berberidaceæ (Vol. II, p. 73).—Flowers regular, solitary or racemose, cyclic, homo- or heterochlamydeous; sepals 4–6; petals 4–6; stamens 4–6; anthers opening by valves; carpel 1; fruit a berry, or dry.

Sub-Family. Berberidoideæ.

*Tribe* 1. *Berberideæ.*

*Genus. Berberis* (Vol. II, p. 75)

*Tribe* 2. *Epimedieæ.*

*Genus. Epimedium.*

Order 11. Rhœadales.—Flowers cyclic, except sometimes the stamens, heterochlamydeous, rarely apetalous, or homochlamydeous, hypogynous, regular or not; carpels (many to 2); ovary superior.

Sub-Order 1. Rhœadineæ.—Flowers usually heterochlamydeous, sepals 2 as a rule.

Family 1. Papaveraceæ (Vol. II, p. 80).—Flowers regular, bisexual; sepals 2, caducous; petals 4; stamens indefinite; ovary syncarpous, unilocular; ovules numerous, on projecting parietal placentæ; stigma sessile; fruit a capsule.

Sub-Family 1. Papaveroideæ.

*Tribe* 1. *Chelidonieæ.*

*Genus. Chelidonium.*

*Tribe* 2. *Papavereæ.*

*Genera. Glaucium* (Vol. II, p. 85), *Rœmeria, Meconopsis, Papaver* (Vol. II, p. 82).

Sub-Family 2. Fumarioideæ.

*Genera. Corydalis, Fumaria* (Vol. II, p. 88).

SUB-ORDER 2. CAPPARIDINEÆ.—Flowers heterochlamydeous; sepals 4 or more.

Family 2. Cruciferæ (Introductory Vol., p. 53; Vol. II, p. 92).—Flowers regular, or irregular in *Iberis*, bisexual, in racemes; sepals 4; petals 4, cruciform; stamens 6 (4 long, 2 short) or 4; ovary syncarpous, of 2 carpels; loculus divided by septum connecting 2 parietal placentæ; fruit a siliqua or silicule, rarely indehiscent.

(*a*) Siliquosæ.

*Tribe* 1. *Arabideæ* (*Siliquosæ pleurorhizæ*).

*Genera. Matthiola, Cheiranthus, Nasturtium, Barbarea, Arabis, Cardamine* (Introductory Vol., p. 55), *Dentaria.*

*Tribe* 2. *Sisymbrieæ.**

*Genera. Sisymbrium, Erysimum* (Vol. II, p. 97), *Hesperis.*

*Tribe* 3. *Brassiceæ.*†

*Genera. Brassica* (Vol. II, p. 79), *Diplotaxis.*

* (*Siliquosæ notorhizæ*).

† (*Siliquosæ orthoplocæ*).

(*b*) Siliculosæ.

A. *Latiseptæ.*

*Tribe* 4. *Alysseæ.*

*Genera. Draba* (Vol. II, p. 101), *Alyssum, Cochlearia.*

*Tribe* 5. *Camelineæ* (*Latiseptæ notorhizæ*).

*Genus. Camelina.*

*Tribe* 6. *Subularieæ* (*Latiseptæ diplecolobæ*).

*Genus. Subularia* (Vol. II, p. 105).

B *Angustiseptæ.*

*Tribe* 7. *Thlaspieæ* (*Angustiseptæ pleurorhizæ*).

*Genera. Thlaspi* (Vol. II, p. 107), *Iberis, Teesdalia, Hutchinsia.*

*Tribe* 8. *Lepidieæ.*

*Genera. Capsella* (Introductory Vol., p. 58), *Lepidium.*

*Tribe* 6. *Brachycarpeæ* (*Angustiseptæ diplecolobæ*).

*Genus. Coronopus.*

(*c*) Nucumentaceæ.

*Tribe* 10. *Isatideæ* (*Nucumentaceæ notorhizæ*).

*Genus. Isatis.*

(*d*) Lomentaceæ.

*Tribe* 11. *Cakilineæ* (*Lomentaceæ pleurorhizæ*).

*Genus. Cakile* (Vol. II, p. 110).

*Tribe* 12. *Raphaneæ* (*Lomentaceæ orthoplocæ*).

*Genera. Crambe, Raphanus* (Vol. II, p. 112).

SUB-ORDER 3. RESEDINEÆ.—Flowers spiro-cyclic, heterochlamydeous.

Family. Resedaceæ (Vol. II, p. 114).—Flowers irregular, in racemes, spiral to cyclic, bisexual; sepals 4–8; petals 4–8, deeply cleft; stamens indefinite; ovary syncarpous, unilocular; ovules numerous, on 3–6 parietal placentæ; fruit a capsule.

*Genus. Reseda* (Vol. II, p. 116).

ORDER 12. SARRACENIALES. — Flowers hemicyclic to cyclic, homo- or heterochlamydeous, hypogynous, regular; gynœcium inferior (3–5), with parietal or axile placentæ and numerous ovules; seed small with endosperm; herbs, with alternate, entire, insect-catching leaves.

Family. Droseraceæ (Vol. II, p. 224).—Flowers actinomorphic, cyclic, heterochlamydeous, bisexual; sepals, petals, and stamens 4–5, hypogynous or perigynous; ovary syncarpous, unilocular, carpels (3–5); ovules numerous, on 2–5 parietal placentæ; fruit a 2–5-valved capsule.

*Genus.* *Drosera* (Vol. II, p. 226).

ORDER 13. ROSALES.—Flowers cyclic, heterochlamydeous, or apetalous, hypogynous to epigynous, regular or zygomorphic; carpels free or united.

SUB-ORDER 1. SAXIFRAGINEÆ.—Carpels and petals equal in number or fewer. Endosperm generally abundant, except in *Crassulaceæ*.

Family 1. Crassulaceæ.—Flowers actinomorphic, cyclic, heterochlamydeous, perigynous, parts 3–30, usually bisexual; calyx and corolla 4–12-partite, united in *Cotyledon;* carpels free, usually 3; fruit an aggregate of follicles.

*Genera.* *Sedum* (Vol. II, p. 222), *Sempervivum*, *Cotyledon* (Vol. II, p. 219), *Crassula* (including *Tillæa*).

Family 2. Saxifragaceæ (Vol. II, p. 211).—Flowers actinomorphic, cyclic, usually heterochlamydeous, bisexual,

perigynous or epigynous; petals 5; stamens 5 or 10; ovary superior or inferior, unilocular, with 2 parietal placentæ, or bilocular with axile placentæ; styles free; fruit a capsule or berry.

Sub-Family 1. Saxifragoideæ.

*Tribe* 1. *Saxifrageæ.*

*Genera. Saxifraga* (Vol. II, p. 213), *Chrysosplenium.*

*Tribe* 2. *Parnassieæ.*

*Genus. Parnassia.*

Sub-Family 2. Ribesoideæ.

*Genus. Ribes* (Vol. II, p. 216).

SUB-ORDER 2. ROSINEÆ.—Ovules with 2 integuments, endosperm scanty or wanting.

Family 3. Platanaceæ.—Flowers capitulate, cyclic, heterochlamydeous, regular, 3–8–partite; stamens short; carpels free; ovules 1–2, orthotropous.

*Genus. Platanus.*

Family 4. Rosaceæ (Introductory Vol., p. 95; Vol. II, p. 203).—Flowers actinomorphic, cyclic, usually heterochlamydeous, and perigynous; sepals and petals usually 4–5; stamens usually indefinite; carpels 1–4 or 6, indefinite, usually apocarpous; ovules 1–2; styles usually distinct, apical, or on ventral side of carpels; fruit a follicle, indehiscent, drupe, or false fruit.

Sub-Family 1. Spiræoideæ.

*Tribe. Spiræeæ.*

*Genus. Spiraea.*

Sub-Family 2. Pomoideæ.

*Genera. Cotoneaster, Pirus* (Introductory Vol., p. 108), *Cratægus* (Introductory Vol., p. 110), *Mespilus.*

Sub-Family 3. Rosoideæ.

*Tribe* 1. *Potentilleæ.*

*Genera. Rubus* (Introductory Vol., p. 104), *Fragaria* (Vol. II, p. 205), *Potentilla, Dryas, Geum.*

*Tribe* 2. *Ulmarieæ.*

*Genus. Ulmaria* (Introductory Vol., p. 102).

*Tribe* 3. *Sanguisorbeæ.*

*Genera. Agrimonia, Alchemilla, Poterium* (Vol. II, p. 209.)

*Tribe* 4. *Roseæ.*

*Genus. Rosa* (Introductory Vol., p. 106).

Sub-Family 4. Prunoideæ.

*Genus. Prunus* (Introductory Vol., p. 98).

Family 5. Leguminosæ (Introductory Vol., p. 84; Vol. II, p. 195).—Flowers zygomorphic, usually in racemes, cyclic, heterochlamydeous, papilionaceous, hypogynous, bisexual as a rule; sepals and petals 5; stamens 10, di- or monadelphous; 1 carpel; ovules many; style terminal; fruit a pod or lomentum.

Sub-Family. Papilionatæ.

*Tribe* 1. *Genisteæ.*

*Genera. Lupinus, Genista, Ulex, Cytisus* (Introductory Vol., p. 87).

*Tribe* 2. *Trifolieæ.*

*Genera. Ononis, Trigonella, Medicago, Melilotus* (Introductory Vol., p. 89), *Trifolium* (Introductory Vol., p. 91).

*Tribe* 3. *Loteæ.*

*Genera. Anthyllis, Lotus* (Vol. II, p. 198).

*Tribe* 4. *Astragaleæ.*

*Genera. Astragalus* (Vol. II, p. 200), *Oxytropis.*

*Tribe* 5. *Hedysareæ.*

*Genera. Onobrychis, Hippocrepis, Ornithopus* (Vol. II, p. 201).

*Tribe* 6. *Vicieæ.*

*Genera. Vicia* (Introductory Vol., p. 93), *Lathyrus.*

ORDER 14. GERANIALES.—Flowers cyclic, heterochlamydeous, or apetalous, rarely naked, usually 5-merous; andrœcium various; carpels (5–2) rarely more, in one whorl, often separated from one another again when ripe, usually with 2–1 rarely indefinite ovules; ovule with ventral raphe and micropyle facing upwards, or if more than 1 ovule present, some sometimes with dorsal raphe and micropyle facing downwards.

SUB-ORDER 1. GERANIINEÆ.—Flowers usually actinomorphic, heterochlamydeous; anthers opening by longitudinal slits; ovules with 2 integuments.

Family 1. Geraniaceæ (Introductory Vol., p. 74; Vol. II, p. 166).—Flowers regular; sepals and petals 5; stamens 5–10; carpels 5; ovary syncarpous, 5-locular; styles 1; ovules 1–2; fruit a capsule or schizocarp splitting into 5 mericarps.

*Tribe* 1. *Geranieæ.*

*Genera.* *Geranium* (Introductory Vol., p. 76), *Erodium.*

Family 2. Oxalidaceæ.—Flowers 5-partite; stamens 10; fruit a capsule or berry.

*Genus.* *Oxalis* (Vol. II, p. 168).

Family 3. Linaceæ (Vol. II, p. 161).—Flowers actinomorphic, 4–5-partite; petals soon falling, convolute; stamens 5–20, united below; ovary syncarpous, 4–5-locular; ovules 2 in each loculus, on axile placentæ; styles 4–5; fruit a capsule.

*Tribe.* *Eulineæ.*

*Genera.* *Linum* (Vol. II, p. 163), *Radiola.*

SUB-ORDER 2. POLYGALINEÆ.—Flowers actinomorphic or zygomorphic; stamens in 2 whorls; anthers opening by pores; carpels (2).

Family 4. Polygalaceæ (Vol. II, p. 139).—Flowers zygomorphic, 5-partite; sepals 5, 2 larger, petaloid, winged; petals 3; stamens 8, united into a tube below; ovary syncarpous, 2-locular; ovule 1 in each loculus, on axile placenta; style 1; fruit a capsule.

*Genus. Polygala* (Vol. II, p. 141).

SUB-ORDER 3. TRICOCCÆ.—Flowers actinomorphic, often reduced; carpels 3; seed with caruncle.

Family 5. Euphorbiaceæ (Vol. III, p. 233). —Flowers apetalous; inflorescence compound, cymose, ultimate branches cyathia, in involucre of 5 fused bracts; male flowers many, of 1 stamen; female flowers solitary, terminal, 3-locular; styles 3; fruit a capsule splitting into 3 mericarps.

Sub-Family. Crotonoideæ.

*Tribe* 1. *Acalypheæ.*

*Genus. Mercurialis* (Vol. III, p. 242).

*Tribe* 2. *Euphorbieæ.*

*Genus. Euphorbia* (Vol. III, p. 237).

SUB-ORDER 4. CALLITRICHINEÆ.

Family 6. Callitrichaceæ. — Plant monœcious; flowers naked, with 2 sickle-shaped bracteoles; male flower of 1 terminal stamen; female of 2 carpels; fruit a drupe-like mericarp.

*Genus. Callitriche* (Vol. II, p. 237).

ORDER 15. SAPINDALES.—Like Gerianales, but ovules in the reverse position, pendulous with dorsal raphe and micropyle facing upwards, or ascending with ventral raphe and micropyle facing downwards.

SUB-ORDER 1. BUXINEÆ.—Flowers haplochlamydeous; ovules with 2 integuments.

Family 1. Buxaceæ.—Flowers regular; stamens 4 to

many; carpels (3); ovules 1–2; styles separate; fruit a capsule or drupe.

*Genus. Buxus* (Vol. III, p. 238).

SUB-ORDER 2. EMPETRINEÆ. — Flowers heterochlamydeous; each carpel with 1 ascending ovule; carpels not separating when ripe.

Family 2. Empetraceæ (Vol. II, p. 177).—Flowers bisexual, regular; perianth of 6 scales, calyx, corolla; stamens 2–3; ovules 1 in each loculus; ovary 3–9–locular; fruit a drupe.

*Genus. Empetrum* (Vol. II, p. 179).

SUB-ORDER 3. CELASTRINEÆ.—Flowers heterochlamydeous, actinomorphic; parts few; rarely equal.

Family 3. Aquifoliaceæ (Introductory Vol., p. 78).—Flowers unisexual, actinomorphic, 4–5–partite; plant diœcious; no disc; petals 4–5, united below; stamens 4–5, free or attached to petals; ovary free, syncarpous, usually 4-locular; fruit a drupe, with 4 stones.

*Genus. Ilex* (Introductory Vol., p. 80).

Family 4. Celastraceæ (Vol. II, p. 183).—Flowers regular, bisexual as a rule, 4–5–partite; sepals and petals, 4–5; stamens 4–5; disc fleshy; carpels (2–5); ovules 1 to many; fruit a capsule or berry; seeds with an arillus.

*Genus. Euonymus* (Vol. II, p. 185).

Family 5. Staphyleaceæ.—Flowers 5-partite; stamens 5; carpels (2–3), free above; ovules few to many; fruit capsular.

*Genus. Staphylea.*

SUB-ORDER 4. SAPINDINEÆ.—Flowers heterochlamydeous, regular or obliquely irregular; ovules with 2 integuments.

Family 6. Aceraceæ (Vol. II, p. 191).—Flowers actinomorphic; calyx and corolla 4–10; stamens usually 5; ovary syncarpous, 2-lobed, 2-locular; ovules 2 in each loculus; fruit a schizocarp of 2-winged mericarps (samaras).

*Genus. Acer* (Vol. II, p. 192).

Family 7. Hippocastanaceæ.—Inflorescence racemose; flowers obliquely irregular; sepals 5; petals 4–5; stamens 5–8; carpels (3); ovules 2; fruit a capsule.

*Genus. Æsculus.*

SUB-ORDER 5. BALSAMININEÆ.—Flowers heterochlamydeous, irregular; anthers united.

Family 8. Balsaminaceæ.—Flowers bisexual; sepals 3 as a rule, posterior spurred; petals 5; stamens 5; carpels (5); ovules indefinite; fruit a capsule.

*Genus. Impatiens* (Vol. II, p. 173).

ORDER 16. RHAMNALES.—Flowers cyclic, diplochlamydeous, sometimes apetalous, haplostemonous, with stamens opposite to the petals, regular; carpels (5–2), each with 1–2 ascending ovules with 2 integuments.

Family. Rhamnaceæ (Vol. II, p. 187).—Flowers actinomorphic, in axillary cymes, 5–4–partite, perigynous or epigynous; sepals and petals 4–5; stamens 4–5, opposite the petals; carpels (5–2); ovary syncarpous, 2-lobed, 3-locular; fruit a 2–4 seeded drupe.

*Tribe. Rhamneæ.*

*Genus. Rhamnus* (Vol. II, p. 189).

ORDER 17. MALVALES.—Flowers cyclic, heterochlamydeous, rarely apetalous, hermaphrodite or rarely unisexual, actinomorphic; sepals and petals usually 5; calyx always valvate; stamens indefinite, or in 2 whorls with the inner divided; carpels (2 to indefinite), each with 1 to indefinite anatropous ovules.

Sub-Order. Malvineæ.—Sepals mostly valvate; mucilage present.

Family 1. Tiliaceæ (Introductory Vol., p. 70).—Flowers actinomorphic, bisexual; sepals and petals 5; stamens indefinite, monadelphous; ovary syncarpous, 5-locular, style simple; ovules 2 in each loculus; fruit globular, 1–2 seeded nut.

*Genus. Tilia* (Introductory Vol., p. 71).

Family 2. Malvaceæ (Vol. II, p. 154).—Flowers actinomorphic; sepals 5, valvate, persistent, with epicalyx of 3–9 leaves; petals 5, convolute, joined below to staminal tube; stamens indefinite, monadelphous; ovary syncarpous, many locular; 1 ovule in each loculus; styles free above; fruit a schizocarp with many 1-seeded cocci.

*Tribe. Malveæ.*

*Genera. Lavatera, Althæa, Malva* (Vol., II, 156).

Order 18. Parietales.—Flowers cyclic, or hemicyclic, stamens and carpels often indefinite; heterochlamydeous, rarely apetalous, hypogynous or epigynous; carpels united with parietal placentæ.

Sub-Order 1. Theineæ.—Stamens often indefinite, gynœcium free, on convex or flat flower-axis. Placentation often axile. Endosperm containing oil and proteid grains.

Family 1. Guttiferæ (Vol. II, p. 150).—Sepals and petals often 5, sepals overlapping; stamens often indefinite, and united in bundles; carpels (3–5) with 1 to many ovules with 2 integuments.

Sub-Family. Hypericoideæ.

*Tribe. Hypericeæ.*

*Genus. Hypericum* (Vol. II, p. 152).

Sub-Order 2. Tamaricineæ.—Stamens in whorls or

if indefinite in bundles; gynœcium free, on flat flower-axis; endosperm starchy or absent.

Family 2. Elatinaceæ (Vol. II, p. 147).—Flowers cyclic, actinomorphic, very small, 4–6–partite; sepals and petals 3–4 or 2–5, imbricate; stamens 6–8; ovary syncarpous, 3–4 or 2–5–locular; ovules indefinite, on axile placentæ; styles 3–4 or 2–5; fruit a capsule.

*Genus.* *Elatine* (Vol. II, p. 148).

Family 3. Frankeniaceæ (Vol. II, p. 125).—Flowers actinomorphic, 4–6–partite; calyx-tube persistent; sepals, petals, stamens 4–6; ovary syncarpous, 2–5 carpels, 1-locular; placentæ parietal, style 1, slender; fruit a capsule.

*Genus.* *Frankenia* (Vol. II, p. 127).

Family 4. Tamaricaceæ (Vol. II, p. 143).—Flowers actinomorphic, small, 4–5–partite; sepals and petals 4–5; stamens 4–5 or twice as many or indefinite; carpels (5–2); ovary usually 1-locular; ovules indefinite; fruit a capsule.

*Tribe.* *Tamariceæ.*

*Genus.* *Tamarix* (Vol. II, p. 145).

SUB-ORDER 3. CISTINEÆ.—Stamens indefinite, not in bundles; gynœcium free, on flat or convex axis; endosperm with starch.

Family 5. Cistaceæ (Vol. II, p. 119).—Flowers actinomorphic; sepals 5–3, 2 outer smaller; petals 5–3 or 0, convolute, fugacious; stamens indefinite; ovary syncarpous, 1-locular; (5–10) carpels; ovules on parietal placentæ; style simple; stigmas 3; fruit a 3-valved capsule.

*Genus.* *Helianthemum* (Vol. II, p. 120).

SUB-ORDER 4. FLACOURTIINEÆ.—Stamens often 5; gynœcium free, on convex or tubular axis, rarely adnate to axis; endosperm copious.

Family 6. Violaceæ (Introductory Vol., p. 60).—Flowers zygomorphic, or actinomorphic, 5-partite; sepals, petals, stamens 5, lower petal spurred; carpels (3); ovules

1 to many, anatropous, on parietal placentæ; fruit a 3-valved capsule.

*Tribe. Violeæ.*

*Genus. Viola* (Vol. II, p. 62).

ORDER 19. MYRTIFLORÆ.—Flowers cyclic, heterochlamydeous, rarely apopetalous, haplo- or diplostemonous; axis tubular; gynœcium (2 to indefinite), rarely free, usually united to axis; herbs and woody plants with alternate or more often opposite or whorled leaves.

SUB-ORDER 1. THYMELÆAINEÆ.—Flower axis more or less tubular (except in male flowers of Elæagnaceæ); gynœcium of 2–4 carpels, free from the flower axis.

Family 1. Thymelæaceæ (Vol. III, p. 215).—Flowers bisexual, heterochlamydeous or apopetalous, 4-partite as a rule, homochlamydeous; perianth tubular, 4-lobed, green or red, stamens 8 in 2 series; fruit a berry or drupe.

Sub-Family. Thymelæoideæ.

*Genus. Daphne* (Vol. III, p. 217).

Family 2. Elæagnaceæ (Vol. III, p. 219).—Flowers unisexual, homochlamydeous, 4-partite as a rule; male flowers in axillary clusters; perianth of 2 leaves; stamens 4; female flowers solitary; perianth 2–6 cleft; carpels 1, with 1 erect ovule; fruit an achene, enclosed in orange-coloured fleshy base of the perianth (receptacle).

*Genus. Hippophäe* (Vol. III, p. 221).

SUB-ORDER 2. MYRTINEÆ.—Flowers with tubular axis and 2 indefinite carpels forming syncarpous gynœcium united to axis; ovules with 1 integument.

Family 3. Lythraceæ (Vol. II, p. 239).—Flowers actinomorphic or zygomorphic, heterochlamydeous or

apopetalous, bisexual, 4–6–partite; sepals and petals 4–6, latter crumpled in bud; stamens 8–12; carpels (2–6); ovules 2 to many, free from flower-axis; ovary syncarpous, 2-locular; fruit a 2-valved capsule.

*Tribe. Lythreæ.*

*Genera. Lythrum* (Vol. II, p. 240), *Peplis.*

Family 4. Epilobiaceæ (Vol. II, p. 243, under Onagraceæ).—Flowers actinomorphic, heterochlamydeous, bisexual, epigynous; sepals and petals 2–4, convolute; stamens 2–4 or 8; ovary inferior, syncarpous, 4-locular, with axile placentæ; fruit a capsule or nut.

*Tribe. Œnothereæ.*

*Genera. Ludwigia, Epilobium* (Vol. II, p. 245), *Œnothera* (Vol. II, p. 247), *Circæa* (Vol. II, p. 249), *Fuchsia.*

Family 5. Halorrhagaceæ (Vol. II, p. 230).—Flowers small, heterochlamydeous, apopetalous by reduction, unisexual; sepals 2–4 or 0; stamens 8, 4, 2 or 1; ovary inferior, of 1 carpel or syncarpous and 4-locular; ovule 1 in each loculus.

Sub-Family 1. Halorrhagoideæ.

*Genus. Myriophyllum* (Vol. II, p. 235).

SUB-ORDER 3. HIPPURIDINEÆ.—Flowers epigynous; stamen 1; 1 carpel; 1 ovule without integument.

Family 6. Hippuridaceæ.—Flowers small, axillary, naked; carpel 1 with 1 undivided style.

*Genus. Hippuris* (Vol. II, p. 232).

ORDER 20. UMBELLALES (UMBELLIFLORÆ).—Flowers cyclic, heterochlamydeous, usually haplostemonous, epigynous, 5–4-partite rarely indefinite, usually bisexual, actinomorphic; carpels (5–1) or (indefinite), each with 1 or rarely 2 pendulous,

anatropous ovule, seed with rich endosperm, flowers usually in umbels.

Family 1. Araliaceæ (Introductory Vol., p. 117).—Flowers small, green, in simple or compound umbels, actinomorphic, parts in fives; sepals, petals, stamens 5; ovary 5-locular; ovules 1, anatropous; fruit a 5-stoned drupe.

*Tribe. Scheffrereæ.*

*Genus. Hedera* (Introductory Vol., p. 119).

Family 2. Umbelliferæ (Introductory Vol., p. 111; Vol. II, p. 258).—Flowers small, in simple or compound umbels, haplostemonous, usually actinomorphic, 5-partite; sepals 5, minute; petals epigynous, 5; stamens 5 at base of stylopodium; gynœcium (2) median; fruit a schizocarp of 2 mericarps, pendulous on the carpophore.

Sub-Family 1. Hydrocotyloideæ.

*Tribe* 1. *Hydrocotyleæ.*

*Genus. Hydrocotyle* (Vol. II, p. 261).

Sub-Family 2. Saniculoideæ.

*Tribe* 2. *Saniculeæ.*

*Genera. Sanicula, Astrantia, Eryngium* (Vol. II, p. 263).

Sub-Family 3. Apioideæ.

(*a*) Haplozygieæ.

*Tribe* 3. *Scandicineæ.*

*Sub-Tribe* 1. *Scandicinæ.*

*Genera. Conopodium, Scandix, Myrrhis, Chærophyllum, Anthriscus* (Introductory Vol., p. 114).

*Sub-Tribe* 2. *Caucalinæ.*

*Genus. Caucalis* (including *Torilis*) (Vol. II, p. 265).

*Tribe* 4. *Coriandreæ.*

*Genus. Coriandrum.*

*Tribe* 5. *Smyrnieæ.*

*Genera. Physospermum, Conium, Smyrnium.*

*Tribe* 6. *Ammineæ.*

*Sub-Tribe* 1. *Carinæ.*

*Genera. Bupleurum, Trinia, Apium, Carum, Sison, Cicuta, Sium, Ægopodium, Pimpinella.*

*Sub-Tribe* 2. *Seselinæ.*

*Genera. Seseli, Fœniculum, Crithmum, Œnanthe, Æthusa, Silaus, Meum, Ligusticum, Selinum.*

*Tribe* 7. *Peucedaneæ.*

*Sub-Tribe* 1. *Angelicinæ.*

*Genus. Angelica* (including *Archangelica*) (Introductory Vol., p. 116).

*Sub-Tribe* 2. *Ferulinæ.*

*Genus. Peucedanum.*

*Sub-Tribe* 3. *Tordyliinæ.*

*Genera. Heracleum, Tordylium.*

(*b*) Diplozygieæ.

*Tribe* 8. *Dauceæ.*

*Genus. Daucus.*

Family 3. Cornaceæ (Vol. II, p. 268).—Flowers actinomorphic, small, in cymes, umbels, or heads; 4–5-partite (sepals, petals, stamens); carpels 4–1; ovary 2-locular; fruit a 2-stoned drupe.

Sub-Family. Cornoideæ.

*Genus. Cornus* (Vol. II, p. 270).

## SUB-CLASS II. METACHLAMYDEÆ (SYMPETALÆ).

Perianth in higher stage of development, always originally in 2 whorls; the inner gamophyllous, in a few cases polyphyllous or absent, though normal in closely related forms.

A. *Polypetaly, as well as sympetaly, occurs; 2 whorls, or 1 whorl, of stamens; usually hypogynous; sometimes epigynous.*

ORDER 1. ERICALES.—Flowers 5- to 4-merous, obdiplostemonous, or the stamens before the petals absent, bisexual, usually actinomorphic; petals free or united; stamens hypogynous or epigynous, rarely united to corolla at base; carpels (2 to indefinite); when isomerous, usually opposite petals; ovary superior or inferior.

Family 1. Pirolaceæ (Vol. II, p. 319).—Flowers solitary or in racemes, obdiplostemonous, 5–4–partite; petals free or united; stamens hypogynous; carpels (5–4); ovules indefinite, minute; fruit a capsule.

Sub-Family 1. Piroloideæ.

*Genus. Pirola* (including *Moneses*).

Sub-Family 2. Monotropoideæ.

*Tribe. Monotropeæ.*

*Genus. Monotropa* (Vol. II, p. 320).

Family 2. Ericaceæ (Introductory Vol., p. 151; Vol. II, p. 314).—Flowers solitary or in racemes, obdiplostemonous, 5–4–partite; stamens 5, 8, 10; anthers usually opening by apical pores; pollen in tetrads; gynœcium syncarpous; ovules 1 to indefinite; styles 1.

Sub-Family 1. Rhododendroideæ.

*Tribe* 1. *Ledeæ.*

*Genus. Ledum.*

*Tribe* 2. *Rhododendreæ.*

*Genus. Rhododendron* (including *Azalea*).

*Tribe* 3. *Phyllodoceæ.*

*Genera. Loiseluria, Phyllodoce, Dabœcia.*

Sub-Family 2. Arbutoideæ.

*Tribe* 4. *Andromedeæ.*

*Genus. Andromeda.*

*Tribe* 5. *Arbuteæ.*

*Genera. Arbutus, Arctostaphylos.*

Sub-Family 3. Vaccinioideæ.

*Tribe* 6. *Vaccinieæ.*

*Genus. Vaccinium* (including *Oxycoccus*) (Vol. II, p. 316).

Sub-Family 4. Ericoideæ.

*Tribe* 7. *Ericeæ.*

*Genera. Erica* (Introductory Vol., p. 153), *Calluna.*

ORDER 2. PRIMULALES.—Flowers 5 or rarely 4-partite to indefinite, typically diplostemonous, but usually haplostemonous, with stamens opposite to petals and epipetalous, hermaphrodite or unisexual, usually actinomorphic; petals rarely free; ovary superior to inferior, unilocular, with 1 to indefinite ovules, on basal or free-central placenta.

Family. Primulaceæ (Introductory Vol., p. 158; Vol. II, p. 328).—Stamens opposite corolla-lobes; style 1; ovary usually superior; ovules numerous; fruit a capsule.

*Tribe* 1. *Androsaceæ.*

*Sub-Tribe* 1. *Primulinæ.*

*Genus. Primula* (Introductory Vol., p. 162).

*Sub-Tribe* 2. *Hottoniinæ.*

*Genus. Hottonia* (Vol. II, p. 332).

*Tribe* 2. *Cyclamineæ.*

*Genus. Cyclamen.*

*Tribe* 3. *Lysimachieæ.*

*Sub-Tribe* 1. *Lysimachiinæ.*

*Genera. Trientalis, Lysimachia* (Introductory Vol., p. 160).

*Sub-Tribe* 2. *Anagallidinæ.*

*Genera. Glaux, Centunculus, Anagallis* (Vol. II, p. 329).

*Tribe* 4. *Samoleæ.*

*Genus. Samolus* (Vol. II, p. 335).

ORDER 3. PLUMBAGINALES.—Corolla poly- or gamopetalous; stamens in 1 whorl, opposite the petals; gynœcium (5); styles 5; ovary 1-locular; ovule 1, anatropous, with 2 integuments.

Family. Plumbaginaceæ (Vol. II, p. 322).—Inflorescence usually compound; petals free or united; styles 5; ovule 1, basal; fruit a nut, enclosed in the calyx.

*Tribe. Staticeæ.*

*Genera. Armeria* (Vol. II, p. 324), *Statice* (Vol. II, p. 326).

B. *Sympetaly dominant; stamens always in* 1 *whorl; union of carpels sometimes imperfect; usually hypogynous.*

ORDER 4. CONTORTÆ.—Flowers usually 5, rarely 2–6-partite, usually sympetalous; stamens often as many as petals, or fewer, rarely hypogynous, as a rule united to the corolla below; carpels (2); corolla generally convolute, sometimes valvate; leaves nearly always opposite, entire, and ex-stipulate.

SUB-ORDER 1. OLEINEÆ.—Stamens 2; ovules with 1 integument.

Family 1. Oleaceæ (Introductory Vol., p. 155; Vol. III, p. 96). — Flowers in racemes or cymes, 2–6-partite, usually sympetalous, or with petals free, or apopetalous, bisexual or diclinous; calyx and corolla 4, 5, or 6-partite,

or o; stamens 2; carpels (2); ovules 2, anatropous; fruit a capsule, berry, or drupe.

Sub-Family. Oleoideæ.

*Tribe* 1. *Fraxineæ.*

*Genus. Fraxinus* (Introductory Vol., p. 156).

*Tribe* 2. *Syringeæ.*

*Genus. Syringa.*

*Tribe* 3. *Oleeæ.*

*Genus. Ligustrum* (Vol. III, p. 98).

SUB-ORDER 2. GENTIANINEÆ. — Stamens and petals equal; ovary superior, 1 to 2-locular: ovules indefinite, with 1 integument on parietal or axile placentæ.

Family 2. Gentianaceæ (Introductory Vol., p. 164; Vol. III, p. 103).—Flowers in cymes, 4–5-partite, sympetalous, bisexual, actinomorphic; sepals free or united; stamens and petals equal; carpels (2); ovary incompletely 2-locular; ovules indefinite; placentæ parietal; fruit a 2-valved capsule.

Sub-Family 1. Gentianoideæ.

*Tribe* 1. *Chironieæ.*

*Genera. Blackstonia* (= *Chlora*) (Vol. III, p. 105), *Microcala, Cicendia, Centaurium.*

*Tribe* 2. *Swertieæ.*

*Genus. Gentiana* (Vol. III, p. 107).

Sub-Family 2. Menyanthoideæ.

*Genera. Menyanthes* (Introductory Vol., p. 165), *Villarsia.*

Family 3. Apocynaceæ (Vol. III, p. 100).—Calyx and corolla 5-cleft, corolla twisted in bud; stamens 4–5; carpels usually 2, free below; styles united; fruit of 2 follicles, etc.

Sub-Family. Plumerioideæ.

*Tribe. Plumerieæ.*

*Genus. Vinca* (Vol. III, p. 101).

C.—*Sympetaly constant; stamens in one whorl; carpels 2, united throughout; frequently zygomorphic.*

ORDER 5. TUBIFLORÆ.—Flowers typically with 4 isomerous whorls, or with gynœcium reduced, or if zygomorphic, andrœcium also; stamens epipetalous.

SUB-ORDER 1. CONVOLVULINEÆ. — Flowers usually actinomorphic; ovules few, micropyle facing downwards; fruit rarely separating into nutlets.

Family 1. Convolvulaceæ (Vol. III, p. 122).—Flowers 5–4–partite; corolla valvate in bud; stamens 5; carpels (2); ovary 2-locular; ovules 2, basal, erect; style 2-branched; fruit a capsule.

Sub-Family 1. Convolvuloideæ.

*Tribe. Convolvuleæ.*

*Genera. Convolvulus* (Vol. III, p. 123), *Calystegia.*

Sub-Family 2. Cuscutoideæ.

*Genus. Cuscuta* (Vol. III, p. 125).

Family 2. Polemoniaceæ (Vol. III, p. 109).—Flowers usually actinomorphic, 5-partite; carpels (3); ovules usually indefinite; style 1, trifid; fruit a capsule, loculicidal.

Sub-Family. Polemonioideæ.

*Tribe. Polemonieæ.*

*Genus. Polemonium* (Vol. III, p. 110).

SUB-ORDER 2. BORRAGININEÆ.—Like Convolvulineæ but micropyle facing upwards; fruit often separating into nutlets.

Family 3. Borraginaceæ (Vol. II, p. 112).—Flowers in cincinni, usually zygomorphic, 5-partite; ovary deeply 5-lobed, 4-locular by false septa; carpels (2); ovules 2,

anatropous; style simple, inserted between the 4 lobes; fruit separating into 4 nutlets.

Sub-Family. Borraginoideæ.

*Tribe* 1. *Cynoglosseæ.*

*Genera.* *Omphalodes*, *Cynoglossum* (Vol. III, p. 120).

*Tribe* 2. *Eritrichieæ.*

*Genera.* *Asperugo*, *Lappula.*

*Tribe* 3. *Anchuseæ.*

*Genera.* *Symphytum*, *Borrago*, *Anchusa* (including *Lycopsis*) (Vol. III, p. 116), *Pulmonaria.*

*Tribe* 4. *Lithospermeæ.*

*Genera.* *Lithospermum*, *Mertensia*, *Myosotis* (Vol. III, p. 118).

*Tribe* 5. *Echieæ.*

*Genus.* *Echium* (Vol. III, p. 114).

SUB-ORDER 3. VERBENINEÆ.—Flowers usually zygomorphic; ovules 2, rarely 1 in each carpel; fruit often of nutlets.

Family 4. Verbenaceæ (Vol. III, p. 170).—Flowers usually zygomorphic; calyx tubular; corolla tubular, usually 2-lipped; stamens usually 4, didynamous; ovary rounded; 4-locular (by false septa); ovules 4; style terminal; fruit usually a nutlet.

*Tribe.* *Verbeneæ.*

*Genus.* *Verbena* (Vol. III, p. 172).

Family 5. Labiatæ (Introductory Vol., p. 167; Vol. III, p. 175).—Flowers usually zygomorphic, in cymes, often in false whorls; calyx and corolla 5-partite; corolla often 2-lipped; stamens 4, didynamous, with rarely a fifth staminode; carpels (2); ovary deeply 4-lobed, 4-locular (by septa); fruit separating into 4 nutlets.

Sub-Family 1. Ajugoideæ.

*Tribe* 1. *Ajugeæ.*

*Genera.* *Ajuga* (Vol. III, p. 186), *Teucrium.*

Sub-Family 2. Scutellarioideæ.

*Genus. Scutellaria.*

Sub-Family 3. Stachydioideæ.

*Tribe* 2. *Marrubieæ.*

*Genus. Marrubium.*

*Tribe* 3. *Nepeteæ.*

*Genus. Nepeta* (Vol. III, p. 182).

*Tribe* 4. *Stachyeæ.*

*Sub-Tribe* 1. *Brunellinæ.*

*Genus. Brunella* (Introductory Vol., p. 169).

*Sub-Tribe* 2. *Melittinæ.*

*Genus. Melittis.*

*Sub-Tribe* 3. *Lamiinæ.*

*Genera. Galeopsis, Lamium* (Introductory Vol., p. 172), *Leonurus, Ballota, Stachys* (Introductory Vol., p. 171).

*Tribe* 5. *Salvieæ.*

*Genus. Salvia* (Vol. III, p. 180).

*Tribe* 6. *Satureieæ.*

*Genera. Melissa, Satureia* (*Calamintha*), *Origanum, Thymus, Mentha* (Vol. III, p. 178), *Lycopus.*

SUB-ORDER 4. SOLANINEÆ.—Flowers zygomorphic or actinomorphic, 5-partite; stamens 5, 4, or 2; carpels (5), generally (2); ovules indefinite; fruit usually a capsule.

Family 6. Solanaceæ (Vol. III, p. 127).—Flowers terminal, inflorescence usually cymose, flowers bisexual, actinomorphic, rarely zygomorphic, 5-partite; stamens often coherent; carpels (2); ovules indefinite; style 1; fruit a berry or capsule.

*Tribe* 1. *Solaneæ.*

*Genera. Lycium, Atropa* (Vol. III, p. 133), *Hyoscyamus* (Vol. III, p. 129), *Solanum* (Vol. III, p. 131).

*Tribe* 2. *Datureæ.*

*Genus. Datura.*

Family 7. Scrophulariaceæ (Vol. III, p. 139).—Flowers bisexual, more or less zygomorphic, 5-partite; corolla usually 2-lipped; stamens 4, or 5, or 2, in pairs; carpels (2); ovary 2-locular; ovules many, axile, anatropous; fruit a capsule or berry.

Sub-Family 1. Pseudosolanoideæ.

*Tribe* 1. *Verbasceæ.*

*Genus. Verbascum* (Vol. III, p. 140).

Sub-Family 2. Antirrhinoideæ.

*Tribe* 2. *Antirrhineæ.*

*Genera. Antirrhinum, Linaria* (Vol. III, p. 142), *Elatinoides, Cymbalaria.*

*Tribe* 3. *Cheloneæ.*

*Genus. Scrophularia* (Vol. III, p. 144).

*Tribe* 4. *Gratioleæ.*

*Genera. Mimulus* (Vol. III, p. 147), *Limosella.*

Sub-Family 3. Rhinanthoideæ.

*Tribe* 5. *Digitaleæ.*

*Genera. Sibthorpia* (Vol. III, p. 149), *Veronica* (Vol. III, p. 152), *Digitalis* (Vol. III, p. 150), *Erinus.*

*Tribe* 6. *Rhinantheæ.*

*Genera. Melampyrum* (Vol. III, p. 154), *Bartschia, Euphrasia, Rhinanthus, Pedicularis.*

Family 8. Orobanchaceæ (Vol. III, p. 156).—Flowers in terminal raceme, zygomorphic, 5-partite; corolla gaping; stamens 4, in pairs, didynamous; carpels (2); ovules indefinite, with 2 parietal placentæ; style 1; fruit a capsule.

*Genera Lathræa, Orobanche* (Vol. III, p. 158).

Family 9. Lentibulariaceæ (Vol. III, p. 161).—Flowers usually zygomorphic, 5-partite; corolla 2-lipped; stamens 2; carpels (2); ovules many; ovary 1-locular; placentation free-central; fruit a capsule.

*Tribe. Utricularieæ.*

*Genera. Utricularia* (Vol. III, p. 167), *Pinguicula* (Vol. III, p. 163).

ORDER 6. PLANTAGINALES.—Flowers 4-merous, isomerous, except in carpels, bisexual or unisexual, actinomorphic; leaves spiral.

Family. Plantaginaceæ (Vol. III, p. 135).—Flowers unisexual or bisexual, in spikes; calyx 4-partite; corolla 4-lobed; stamens 4, inserted on corolla-tube; anthers versatile; carpels (2) as a rule; ovary 2, or 4-locular; ovules numerous, anatropous; style and stigma thread-like; fruit a capsule or nut.

*Genera. Plantago* (Vol. III, p. 137), *Littorella.*

ORDER 7. RUBIALES. — Flowers typically 5 to 4-merous, with isomerous stamens and carpels, or with latter oligomerous, regular or zygomorphic; gynœcium superior, multilocular, with 1 to many anatropous ovules in each loculus.

Family 1. Rubiaceæ (Vol. II, p. 280).—Flowers actinomorphic as a rule, 5–4–partite; calyx small; corolla-lobes valvate in bud; carpels (2) as a rule (or 1) or indefinite; ovules 1 to indefinite, anatropous; fruit variable.

Sub-Family. Coffeoideæ.

*Tribe. Galieæ.*

*Genera. Sherardia* (Vol. II, p. 288), *Asperula* (Vol. II, p. 285), *Rubia*, *Galium* (Vol. II, p. 281).

Family 2. Caprifoliaceæ (Introductory Vol., p. 123; Vol. II, p. 275).—Flowers actinomorphic or zygomorphic; corolla-lobes usually overlapping in bud; carpels (2–5); ovules 1 to indefinite; fruit a drupe, berry, or capsule.

*Tribe* 1. *Sambuceæ.*

*Genus. Sambucus* (Introductory Vol., p. 124).

*Tribe* 2. *Viburneæ.*

*Genus. Viburnum.*

*Tribe* 3. *Linnæeæ.*

*Genera. Linnæa, Symphoricarpus.*

*Tribe* 4. *Lonicereæ.*

*Genus. Lonicera* (Vol. II, p. 277).

Family 3. Adoxaceæ.—Flowers in 5-flowered heads, 4 terminal, lateral 5-partite, homochlamydeous; calyx 2–3 lobed; stamens 4 or 5–6; carpels (3–5); fruit a drupe, with 1–3 stones.

*Genus. Adoxa.*

Family 4. Valerianaceæ (Vol. II, p. 290).—Flowers zygomorphic; calyx rudimentary; corolla (5) or (3–4) cleft, sometimes with spur; stamens 1–4; carpels (3); ovule 1, anatropous; style 1.

*Tribe. Valerianeæ.*

*Genera. Valerianella* (Vol. II, p. 297), *Valeriana* (Vol. II, p. 291); *Kentranthus* (Vol. II, p. 294).

Family 5. Dipsacaceæ (Introductory Vol., p. 126; Vol. II, p. 299).—Inflorescence a capitulum, outer bracts forming an involucre; flowers usually zygomorphic, bisexual; florets surrounded with an epicalyx; stamens 4 or less; carpels (2); ovary 1-locular; ovule 1, pendulous.

*Genera. Dipsacus* (Introductory Vol., p. 128), *Scabiosa* (Vol. II, p. 300).

Order 8. Cucurbitales.—Flowers typically 5-partite; stamens 5, rarely all free, usually as if 3

by union of 2 pairs, or all 5 may be united into a synandrium.

Family. Cucurbitaceæ (Vol. II, p. 253).—Flowers unisexual, cymose, actinomorphic; calyx and corolla 5-partite; stamens 5, free, or apparently 3 by fusion; anthers often twisted; carpels usually (3); ovary inferior, 3-locular as a rule; fruit usually a berry.

*Tribe. Cucurbiteæ.*

*Genus. Bryonia* (Vol. II, p. 253).

ORDER 9. CAMPANULATÆ. — Flowers typically 5-merous, with usually fewer carpels; anthers close together, often united; gynœcium superior, multilocular, with 1 to indefinite ovules in the loculi, or unilocular with 1 ovule.

Family 1. Campanulaceæ (Introductory Vol., p. 148; Vol. II, p. 312).—Flowers actinomorphic or zygomorphic, bisexual, 5-partite; stamens free or united; anthers introrse; ovary inferior as a rule, 2–5–locular; ovules indefinite, anatropous, on axile placentæ; style 1; fruit usually a capsule.

Sub-Family 1. Campanuloideæ.

*Tribe. Campanuleæ.*

*Sub-Tribe* 1. *Campanulinæ.*

*Genera. Phyteuma, Campanula* (Introductory Vol., p. 149), *Specularia.*

*Sub-Tribe* 2. *Wahlenbergiinæ.*

*Genera. Jasione, Wahlenbergia.*

Sub-Family 2. Lobelioideæ.

*Genus. Lobelia.*

Family 2. Compositæ (Introductory Vol., p. 129; Vol. II, p. 303).—Inflorescence a capitulum, each floret subtended by a small scaly bract, or ebracteate; flowers in

involucrate heads, bisexual, or male and female flowers separate, or sterile, actinomorphic, or zygomorphic; calyx of pappus; corolla tubular, ligulate, or 2-lipped; stamens 5, on corolla-tube; anthers forming a tube; carpels (2); ovary unilocular; ovule erect; fruit a 1-seeded inferior nut.

Sub-Family 1. Tubulifloræ.

*Tribe* 1. *Eupatorieæ.*

*Genus.* *Eupatorium* (Vol. II, p. 306).

*Tribe* 2. *Astereæ.*

*Genera.* *Solidago*, *Bellis* (Introductory Vol., p. 134), *Aster*, *Erigeron.*

*Tribe* 3. *Inuleæ.*

*Genera.* *Filago*, *Antennaria* (including *Anaphalis*), *Gnaphalium* (Vol. II, p. 309), *Inula*, *Pulicaria.*

*Tribe* 4. *Heliantheæ.*

*Sub-Tribe* 1. *Ambrosiinæ.*

*Genus.* *Xanthium.*

*Sub-Tribe* 2. *Coreopsidinæ.*

*Genus.* *Bidens* (Vol. II, p. 310).

*Sub-Tribe* 3. *Galinsoginæ.*

*Genus.* *Galinsoga.*

*Tribe* 5. *Anthemideæ.*

*Sub-Tribe* 1. *Anthemidinæ.*

*Genera.* *Anthemis* (Introductory Vol., p. 139), *Achillea*, *Diotis.*

*Sub-Tribe* 2. *Chrysantheminæ.*

*Genera.* *Matricaria*, *Chrysanthemum* (Introductory Vol., p. 136), *Cotula*, *Tanacetum*, *Artemisia.*

*Tribe* 6. *Senecioneæ.*

*Genera.* *Petasites*, *Tussilago* (Introductory Vol., p. 132), *Doronicum*, *Senecio* (Introductory Vol., p. 138).

*Tribe* 7. *Calenduleæ.*

*Genus.* *Calendula.*

*Tribe* 8. *Cynareæ.*

*Sub-Tribe* 1. *Echinopsinæ.*

*Genus. Echinops.*

*Sub-Tribe* 2. *Carlininæ.*

*Genus. Carlina.*

*Sub-Tribe* 3. *Carduinæ.*

*Genera. Arctium* (Introductory Vol., p. 141), *Carduus*, *Silybum*, *Saussurea*, *Cnicus* (Introductory Vol., p. 142), *Onopordon.*

*Sub-Tribe* 4. *Centaureinæ.*

*Genera. Serratula*, *Centaurea.*

Sub-Family 2. Ligulifloræ.

*Tribe* 9. *Cichorieæ.*

*Sub-Tribe* 1. *Hyoseridinæ.*

*Genus. Cichorium.*

*Sub-Tribe* 2. *Lapsaninæ.*

*Genera. Arnoseris*, *Lapsana.*

*Sub-Tribe* 3. *Crepidinæ.*

*Genera. Picris*, *Crepis.*

*Sub-Tribe* 4. *Hieraciinæ.*

*Genus. Hieracium.*

*Sub-Tribe* 5. *Hypochæridinæ.*

*Genera. Hypochæris*, *Leontodon*, *Taraxacum* (Introductory Vol., p. 146).

*Sub-Tribe* 6. *Lactucinæ.*

*Genera. Sonchus*, *Lactuca.*

*Sub-Tribe* 7. *Scorzonerinæ.*

*Genus. Tragopogon.*

# APPENDIX II

## PRACTICAL NOTES FOR A BOTANICAL COURSE.

THE following notes are intended to enable the beginner to study botany on the lines suggested in these volumes (*vide* Preface and Plan) with little or no appeal to a teacher. There are apparently many would-be botanists to-day who prefer such a method to the more orthodox means of instruction by syllabi. These notes make no claim to be exhaustive nor ideal, and are intended to assist those who prefer, or are obliged, to work *by themselves*. At the same time the notes should prove suggestive for those who wish to take a regular course in the schools at a later stage, or for actual school use.

Again it should be emphasised that the primary aim of this work is to enable the beginner to master botanical principles by studying British plants *in the field*, commencing with *systematic botany*, or identification, and a thorough acquaintance with species. The material thus recognised, or similar species, may then be studied from the more detailed biological *life-history point of view*. It is for this reason that some notes on this head are given under each species, with a view to stimulating interest in this direction. Space limits have precluded the inclusion of many of the other features referred to in the Introduction which all form part of the life-history.

A knowledge of ecology, or plant formations, acquired in

the field will, too, it is opined, stimulate the student to endeavour to discover the relation of the plant to its environment, its requirements, and the functions of plants or their organs; and even to carry out experiments in physiology relating to nutrition, growth, etc.

This will naturally, it is probable, lead to a study of their structure and form, or their morphology, and the connection between these features and the functions of plants. It may be carried as far as their external features, when a study of the different organs and their meaning may be made from the plants themselves in the field; or even extend to their internal features, and embrace a knowledge of anatomy or histology demanding microscopical work. These mastered, the more difficult problems of cytology and embryology will come as a further inquiry in the realm of the unseen, and here also microscopical work is involved to make the invisible visible. Such work is generally not so interesting to the majority of lay students, hence its place in this plan is after enthusiasm has been securely obtained and maintained by more general and less arduous work at first.

If the student, however, wishes to specialise in systematic botany or taxonomic work, he will, having mastered the types here described, next tackle the complete British flora by degrees, supplementing the knowledge thus gained—acquired only by much travel and long experience—by acquainting himself with Continental floras in the field and in the study. In this latter work much labour may be saved by a knowledge of the special monographs and papers dealing with individual genera and orders which are scattered throughout the scientific journals of this country. A few memoranda upon this subject are given. It must be emphasised that in each case only a summary can here be attempted, though this is more than most works attempt,

and besides it is better for the tyro to work out the details for himself or herself.

Lastly, the subject of Fossil Botany, which has in recent years assumed a more important place in botanical work, from the interest taken in the origin and evolution of plants, may be introduced, and therefore a few memoranda on this head are subjoined.

The sequence of study may seem quite arbitrary, but is more especially adapted to the particular line of attack here suggested for acquiring botanical knowledge upon the basis of using the British flora—as any one can study it to-day in any district—and employing the knowledge gained therefrom by progressive study upon what would seem a more rational plan than the large army of the public interested in wild flowers usually adopts. Such a plan must not in any way be supposed to supersede the regular course of the schools, but it may notwithstanding, it is hoped, in many ways prove suggestive even there.

### 1. Systematic Botany (Preliminary Work).

Commencing work when wild flowers are in bloom, or when plant-life is most active, between March and September,[1] the initial study of plants may be divided into three heads;

(A) Observation in the field.

(B) Collection, drying, mounting, preserving of material for future reference.

(C) Systematic survey work, or elementary ecology.

#### (A) *Observation in the Field.*

There are few instruments needed or little apparatus required for this purpose. The beginner should, however,

[1] Really work may be done all the year round, as trees, for example, may be usefully studied in winter.

go out with a *definite* purpose in view. It is possible to study all the members of one or more natural orders whose characters it is desired to learn—*e.g.* Ranunculaceæ or Cruciferæ—and to collect all the species of these orders, to refer each to its genus, and finally to identify each species. Or it may be desired to study all the wild flowers of a particular district, or those of a particular habitat.

A very necessary desideratum is a good lens and a note-book, pencil, possibly, further, a sketching-block. To collect the plants in good condition to take home, a vasculum is needed. Collect only good and typical specimens. Some may wish to study plants only in the field. If so, simple dissecting tools should be carried with one—*e.g.* a scalpel, fine-pointed scissors or knife, a needle or teaser, and a piece of strawboard and small pins to set out the parts. Much depends on whether a knowledge of species or of the floral structure is required. If the beginner wishes merely to identify his or her specimens to begin with, a pocket flora should be carried (see note in Appendix I and Bibliography, Introductory Vol.), and the plant should be examined and run down by aid of the dichotomous keys. Most beginners will, however, wish to carry their specimens home and to study them at leisure, perhaps making their dissections permanent by gumming the parts down upon a paper or cardboard mount (Bristol board), adding water-colour or pencil sketches, with notes thereon, as elaborate as the material allows.

In the field the powers of observation again should be extended, not merely to the study of the bare characters of the plant itself, but to the relation of the plant to the soil, etc., the different stages of the plant from seedling to flowering or fruiting stage, the adaptation to pollination, including notes upon insect visitors, means of dispersal of fruits or seeds, the relation to injurious plants and insects.

Entomologists will here score by a knowledge of insect life. Others may capture specimens and keep them for identification later by themselves or others. The many other features for observation are briefly enumerated in the Introduction to this volume (section 15).

Observation may also be supplemented by photographing the plant in its habitat, thereby preserving a record of the form of the plant and its surroundings. The recording of plant-life day by day in diary form will by degrees afford a fund of information, if regularly sustained. Such a day-diary made in the field may be supplemented by extended notes upon special heads, and this information may be arranged on a card system on any desired lines—*e.g.* colour of flowers, phenology, etc. Though plants should not be dug up wholesale, certain advantages are to be gained by growing types of interest at home in the garden, where they can be studied with ease at all seasons and times.

The relations of plants to man and to other animals may be noted with advantage, the influence of agriculture, tree-felling, drainage, etc., being very important in its effect upon plant-life, and a subject not yet adequately enough studied.

### (B) *Collection, Drying, Mounting, and Preservation of Material for Future Study.*

Brief notes upon this head were given in the Introductory Volume (Appendix). For fuller information, reference may be made to the author's 'Practical Field Botany' (Griffin), where a bibliography is also given.

The seasons when plants can and should be collected are generally cited in most British floras. The habitats of plants and the localities where the types are to be found, to which journeys must be made by the student who wishes to study all the British species he can, will also be found in most British floras; but upon the first and second heads personal

notes should be made to amplify or to correct the information therein to be found.

How to collect plants is a question for individual choice. If they are to be preserved for herbarium purposes they should be *perfect* specimens, *complete*, and *typical.* A series of specimens of the plant in different stages should be collected, if any extended series of observations is desired. Mr. J. Britten, late of the Botanical Department, British Museum (Natural History), long ago emphasised this point. Certain genera require special treatment. Brambles, roses, hawk-weeds, willows, grasses are examples. The barren stem and panicle of a bramble are required, the flowers and later fruit of roses, the radical leaves, fruit as well as flowers, of hawkweeds, the early leaves and catkins (male and female) of willows, and their later leaves, and the roots or rhizomes or stolons of grasses. Since so much depends in plant classification upon the flowers or fruit or seed, these parts should be collected in *good condition.*

The drying of plants is a question for careful thought. Generally speaking, plants dried for the herbarium should be pressed between botanical paper or newspapers. The plants should be arranged in the form in which they are required for mounting, large specimens being bent back. The papers should be changed daily or every six hours. Delicate flowers may be dried separately. Aquatic plants should be floated out. A sufficient supply of paper should be placed between separate plants and adequate pressure applied. A temporary label should be placed with each plant.

The method of mounting of plants is a matter for individual taste. The size of paper is usually 16 × 10 inches or 17 × 11 inches. Single cartridge sheets are usually employed, but some botanists prefer to use a double folded sheet, the upper sheet serving as a cover.

The plants may be fastened down with strips of trans-

parent adhesive paper, or stamp selvage. Some botanists paste the whole plant down, but this prevents them from being examined both sides, and, moreover, tends to encourage mites, whilst the plants are more liable to be injured by handling.

The sheets should bear a label giving such details as the scientific names, local folk-names, locality, habitat, soil, altitude, collector's name, date, number of vice county, and number, on the label or sheet, in the plant list followed, *e.g.* London Catalogue, Druce's List, British Museum List of Seed Plants.

The species are placed together in a strong cover with the name of the genus written on the top or bottom left-hand corner. The genera may be, if not too large, placed in a cover to include all the genera in an order. But genera covers are usually enough.

The plants so mounted may be stored in cabinets with partitions, vertically or horizontally. Care should be taken to prevent the attacks of insects, by the use of naphthaline, either in the form of pads, or in balls, or otherwise. Other methods of preservation are by drying plants without pressure, in sand or sawdust, plaster-of-Paris, by models in wax, by treating them with acetate of copper, or by preservation in formalin, alcohol, or other media. These last are, however, except for microscopic work, or morphological work, more especially adapted for museum purposes, and need not be detailed here.

### (c) *Systematic Survey Work, or Elementary Ecology.*

The study of plants in their natural habitat, or ecology, is a comparatively new study in this country, but its progress has been greatly accelerated during the last ten years, as a result of the recognition of its greater relative value as compared with previous methods of field botany.

Ecology enables one to study the exact environment suited to each plant, its requirements as regards soil, light, heat, moisture, etc. It is now recognised that each plant is characteristic of a particular soil. Of these soils there are six main types, clay or loam, sand, siliceous soils, limestone or chalk, peat or humus, saline soil. Hence some knowledge of geology is required for this work. The bearing of ecology upon agriculture and its economic importance will, however, be evident, and therefore the difficulties involved in this study will be the more readily overcome by those who wish to profit materially, as well as mentally, by a knowledge of ecology.

Under Plant-formations (Introduction, section 9) the main types of plant-formations are briefly described, and the vegetation of any particular district may be assigned to one or more of these.

Elementary methods of survey are given below. For further details, or a more elaborate method, reference may be made to the author's 'Practical Field Botany,' where survey methods are described, and also the use of instruments, etc., for determining the light intensity, temperature, humidity, rainfall, water content, soil texture, with details of how to measure altitude, construct contours, to survey on a detailed plan by the "square" or "gridiron" method for the construction of vegetation maps. It is recommended also that ordnance maps be obtained, and each field and other tract numbered and each area examined in detail, one by one, or that plant lists be drawn up, notes be made on the spot, and that each be numbered with the same number as the area on the map.

The suggestions appended are a compromise between this systematic field to field work, and the old plan of making botanical excursions in the form of haphazard walks to some presumably good locality for plants, when no notes

were made, or if so not until the return home, and thus of less permanent value, than those made on the spot.

1. As far as possible an approximate percentage should be given where a piece of ground is examined in detail. The terms: r. = rare, v. r. = very rare, r. r. = rather rare, f. c. = fairly common, c. = common, and v. c. = very common, may be put in after the excursion has been concluded, or if need be on the spot, or a. = abundant, l. a. = locally abundant, v. a. = very abundant, d. = dominant, l. sd. = locally subdominant, f. = frequent, o. = occasional, r = rare, s. = sporadic.

2. A note should be given after a plant where the habitat is peculiar, whether in flower or on any other points of interest.

3. Where a *road* is chosen, mark the lists with a division for every point such as a village, cross-road, so that if necessary to survey the road to ascertain the exact rock-soil of the species, this can be ascertained within a short distance. This could be done most easily by stating the hedge-boundaries, if the route taken is not a long one. Give abbreviations (as in meadow) for hedge, ditch, roadside, wall, etc.

4. *Rivers* should be zoned, that is to say, apart from the itinerary list of plants made a section across the river should be taken at different points and the bands of vegetation, such as *Carex* or Sweet Flag along the margin, Pondweeds in the middle, *Chara* between (on the bottom) should be given, zoning the plants according as they are terrestrial, semi-aquatic, half-submerged, submerged, with floating leaves, etc.

5. In examining a *wood* note three things:

(1) The *Trees*.—Pick out the dominant one, *e.g.* Oak or Ash, or the two or three principal kinds, noting all others afterwards.

(2) Note next the *scrub.* State if general, discontinuous, or otherwise.

(3) Then note the *ground flora,* and give (after having completely examined such a tract) the percentage of species. This applies also to a lake (see also above, 4).

6. *Heaths and Commons* should be treated in the same way as a complete formation, and after picking out the principal plants give the percentage of others.

7. In *meadow-land* try to estimate the main types of grasses, in each case, and give percentage of species afterwards, as before.

8. Where rocks are exposed state if plants grow on rock, and if it is unknown, break off samples and preserve with the lists, for future determination.

9. A *marsh or bog* is to be treated in the same way as a complete whole, and percentages given. State if the plant is partly submerged or not in either case. Pick out the dominant widespread species first as before.

10. *Waste ground* may be treated also as a complete unit and a percentage note given, estimated roughly by eye, as to the number of each species. If only 1–4 specimens (or less) of an unknown plant presumably rare occur, leave them and make a note of the characters indicating the exact position.

## 2. Physiological Work.

The object of physiology is to determine the functions of organs or their component tissues, etc. It thus deals with such questions as germination, growth, photosynthesis, respiration, transpiration, absorption, movement. In the introductions to Vols. II and III some notes upon these processes have been given. Here it is impossible to give even an outline of experiments to demonstrate these activities, nor a list of the apparatus required in such a

course as that suggested by Dr. F. Cavers, in his 'Practical Botany.' The student is referred to this work, and to others such as Darwin and Acton's 'Physiology of Plants,' where a number of more elaborate experiments are described, also to MacDougal's 'Practical Text-Book of Physiology,' Timiriazeff, 'The Life of a Plant,' Stevens, 'Plant Anatomy,' Ganong, 'The Living Plant,' Green's 'Vegetable Physiology,' Haberlandt's 'Physiology,' Bose's 'Plant Response,' works by Clements. The works of Jost, Pfeffer, Strasburger, Vines are perhaps too exhaustive at first for the beginner.

Dr. Clements's works deal with the special bearing of physiology upon ecology, and may be studied when advanced work in the latter direction has been begun.

In outlining the general requirements of physiological work Dr. Cavers makes some useful preliminary suggestions. Apparatus may be normal or standard apparatus specially suited for fairly accurate results of a quantitative nature, and supplied by Bausch and Lomb from Prof. Ganong's designs (see his 'Plant Physiology'). Or adapted apparatus may be used, and selected from the apparatus used in chemistry and physics courses (*vide* catalogues of Messrs. Baird and Tatlock, Messrs. Flatters and Garnett, Cambridge Scientific Instrument Co., Messrs Leitz). Such apparatus will give correct qualitative results.

For elementary work suited to a nature study course makeshift apparatus may be obtained for temporary purposes, but this will only give roughly accurate results, and delicate measurements or observations cannot be thereby attempted.

A list of general appliances and articles including tools, scales, balance, drying oven, sand-bath, meat-juice press, spectroscope, various chemical and physical apparatus, miscellaneous botanical apparatus, reagents, and chemicals,

is given. This is followed by useful hints on fitting up apparatus.

The carrying out of the experiments is prefaced by some useful hints which I take leave to quote: "In making experiments, sketch the apparatus used. Make notes of the materials experimented with (name of plant or part of plant, number, condition, stage of growth, etc.), the duration of the experiment, date, time of day; the external conditions (temperature, light intensity, barometer-reading, etc.); the precautions which seem necessary and the sources of error which may spoil the results. Always make 'control' or 'check' experiments, using the same form of apparatus set up at the same time, but with one or other of the conditions different, *e.g.* in darkness instead of light, with the plants omitted, with killed instead of living plants, with plants in different stages of growth. Also make 'repeat' experiments, using different plants under similar conditions or the same plants at different times of year or day, etc."

Physiological work with experiments should be undertaken under the guidance of an experienced teacher who will explain the setting up of the apparatus, the special use of each piece, and how to employ the reagents. As a matter of fact some preliminary knowledge of chemistry and physics is necessary before undertaking elaborate physiological experiments.

Some very simple and easily contrived experiments, that can be made with improvised apparatus, are described in Fritsch and Salisbury's 'Introduction to Botany,' which is well illustrated with diagrams.

### 3. Morphological Work.

For general work without the microscope, dealing with the external features, or gross morphology, or anatomy of

plants, it is enough to be provided with a set of dissecting instruments, camel-hair brush, watch glasses, pins, paper, drawing materials or water-colour outfit for sketching, note-book and pencil, and, above all, a good magnifying lens, or simple dissecting microscope, for examination of the external features and juxtaposition of parts of the flower—the smaller details. This applies also to external features or surface of roots, stem, leaves, fruits, etc., including stomata, hairs, glands, lenticels, etc. Here the form and structure of organs —not their function and action, or mode or rate of growth, or other activities—are concerned. Hence work lies rather in the accurate observation of form and outline, relation to other parts, and comparison between homologous parts in other plants.

This part of the work may be confined to the examination of selected types, as adopted in text-book syllabi; or it may be extended to the study of all available types, and the intimate acquaintance between allied orders, genera, or species. Such a course will assist the student in working out the phylogeny of species, and form the basis of a more natural system of classification than can be arrived at by a mere study of specific characters. For these purposes herbarium material, or fresh material, will be useful; but it must be supplemented by material preserved in alcohol, formol, or other media such as phenol, glycerine, etc. (see Lee's 'Microtomist's *Vade-mecum*,' Zimmerman's 'Botanical Microtechnique,' Stevens' 'Plant Anatomy,' etc., Tagg in 'Trans. Bot. Soc. Edinburgh').

In the case of sections of root, stem, leaves, or other parts involving a study of the internal anatomy, cytology (see Walker, 'Essentials of Cytology'), histology, embryology of plants, other methods are required; for the examination of cells, tissues, their contents, structure, form, arrangement, and the study of a sequence of internal changes—*e.g.*

mitosis, germination, maturation, fertilisation—a study of the chromosomes requires a series of slides made at the right time and position in one or more directions.

For this purpose a microscope should be employed. So many works dealing with the microscope have been published that it is unnecessary here to give any but general hints on this head, and reference may be made to Cross and Cole's 'Modern Microscopy,' whilst useful hints will be found in Cavers's 'Practical Botany,' Bower's 'Practical Introduction to Botany,' Stevens' 'Plant Anatomy,' Zimmerman's 'Botanical Microtechnique,' Lee's 'Microtomist's *Vade-mecum*.'

The microscope should be a compound microscope, preferably a Zeiss, with a rigid, firm stand, with suitable eye-pieces, and a set of objectives of high and low power. The tube should be neither too long nor too short. There should be a coarse and a fine adjustment. There should be a nose-piece fitted above the objective to carry a high and low power. The stage on which the object is placed should be provided with clips for the slide. Below the stage is the diaphragm (preferably an iris) for control of the illumination supplied by light falling on the mirror, a small hole being used with a high-power (*e.g.* $\frac{1}{4}$ in.) and a large hole with a low-power (*e.g.* 1 in.) objective. The latter magnifies 60–80 diameters, the former 300–400 diameters. Keep the microscope in good order, the parts oiled where necessary, and the eye-piece, lens, and mirror clean. Examine objects in light from a north aspect—*i. e.* not too direct. The microscope should be vertical when the object is in position, and a low power should be used first, then a high power, in the last case taking care that a cover-glass lies over the object. With a low power the flat mirror should be used; with a high power the concave mirror. Focus with the coarse adjustment first, then, especially with the high-power objectives, with the fine adjustment. The slide must not touch

the objective. Proceed more cautiously in focussing the object with a high power, and move the tube or eye-piece as well as the slide, which must be centred by the stage adjustment. Keep both eyes open when viewing the object, and do not close the one not in use.

The necessary processes involved in the preparation of a microscopical slide—assuming this is undertaken, though not necessary in examining fresh material, which can be examined in water or other media in a cell or moist chamber—includes preservation, fixing or hardening, cutting of sections, and mounting.

As a rule, fresh material is best, but if it has to be kept it may be preserved in alcohol, when it becomes already dehydrated, and at the same time the chlorophyll is extracted, whilst the cell-contents may become disorganised. A better medium is formalin (40 per cent. solution) used as a 4 per cent. solution.

When ready to be used the material should be rinsed with water. If alcohol is used it should be 50 per cent. dilute.

For fixing and hardening contents before preserving in alcohol or formol, the following may be used: Picric acid, saturated solution chromic acid (0·1 to 0·5 per cent. solution in water), osmic acid (0·1 to 1 per cent. solution in water). The object is kept in this for twenty-four hours in 300 c.c. water with 2 grm. chromic acid and 3 c.c. glacial acetic acid, then washed in running water, then placed *per diem* respectively in 30 per cent., 50 per cent., and 70 per cent. alcohol, then it may be finally preserved in 95 per cent. or absolute alcohol. Objects so treated are more brittle than when kept in formol and fixed as above. This defect may be remedied by treating with glycerine, if the section is to be mounted in glycerine (which should be dilute).

The next operation is to cut a section, or rather three sections—transverse, radial longitudinal, and tangential

longitudinal. This is done by means of a razor, hollow ground or with one flat side. The object and razor should be wetted, and the latter dipped in alcohol to prevent air bubbles. The blade and handle should be in the same straight line held in the right hand, the object in the left between the thumb and first finger, the razor edge being towards one. Rest the left wrist and forearm on the table, and the blade against the left forefinger; draw the razor with a sliding motion towards one with a long stroke. This applies to larger objects, but, if they are small, they may be fixed in a slit in a piece of elder pith; or if a microtome or mechanical section cutter is used, and the object is small, the latter may be embedded in paraffin wax, or solid paraffin 2 parts, vaseline 1 part, which is easily melted, and the object is inserted, washed in alcohol beforehand, in a cavity. The melted wax is poured into the cavity so that it covers the specimen. When the wax is cold the object may be sectioned as above, a series being taken and cut ribbon fashion. White of egg may also be used as an embedding medium, whilst spores, etc., may be embedded in gum laid on a piece of pith. In order to free the sections from the embedding material, carbolic acid and turpentine are used to dissolve wax, glycerine and water dissolving gum.

When thus freed the sections are transferred to a watch glass, with a camel-hair brush or water jet, containing a little alcohol or water, and are ready for mounting.

Take a glass slide and cover-glass, which must be quite dry and clean, heated perhaps with sulphuric acid if filmy, then washed. Determine what mounting medium be used beforehand—*e. g.* glycerine, caustic potash, eau de Javelle, chloral hydrate, phenol—the first being used as a permanent mounting medium, the others as clearing reagents. It should also be determined what staining solution is to be used, if any.

Take enough of the medium to fill the space between the cover-glass and slide to extend to the margin, any excess being absorbed by blotting-paper. Let the cover-slide fall obliquely, one edge resting on the medium, and lower it carefully on the slice so that the medium is evenly spread out and no air bubbles are present, using a forceps or needle, alcohol being used to prevent air bubbles beforehand. If any air bubbles are present, heat gently over a spirit lamp or expel them with an air pump.

To apply reagents, the specimen is irrigated. The fluid used is run on to the slide so that it may soak into the medium by capillary attraction along the edges of the cover-slip. Iodine, aniline sulphate, chlor-zinc-iodine are often used. If necessary, the cover-glass may be raised to allow quicker penetration.

In order to render the section clearer, certain reagents for temporary mounts may be used such as those mentioned, potash causing swelling of contents and rendering objects transparent. When this has been applied, the section should be washed in distilled water, and, after being treated with alcoholic solution, in dilute alcohol; then it may be permanently mounted in glycerine after thorough washing. Glycerine itself is a good clearing reagent. If eau de Javelle is used, it should be warmed, the section washed in water and acetic acid, then mounted in glycerine. For embryos chloral hydrate is used, the specimen being soaked in it for several hours, or heated. Calcium chloride is used for the growing points, specimens being placed in a drop of water, the slide covered with the dry powder warmed, and the water evaporated; then a drop of water is placed on the specimen and the section mounted in glycerine. Leaves from which chlorophyll has been extracted in alcohol may be cleared by phenol, or 3 parts turpentine, 1 part phenol.

Staining media are hæmatoxylin, eosin, safranin, aniline

blue, etc. Take a watch glass and pour in some of the solution, which is best diluted, immersing the sections, and keep the sections immersed a fair time; then wash with water or alcohol, according as water or alcohol dissolves the stain. More than one stain may be employed successively, using the necessary solvent for each stain to wash out any excess.

For permanent mounting, glycerine, glycerine jelly, Canada balsam, and dammar may be used. In the case of glycerine the slide may be sealed or merely transferred to glycerine jelly. Dilute glycerine consists of half glycerine, half water Or take for glycerine 2 parts glycerine, 1 part glacial acetic acid, boiled together. The cover is fixed to the slide by a coat of gold size, Brunswick black, Canada balsam, dissolved in benzol or xylol, applied to the edge with a brush. The section is placed in glycerine and kept under a bell jar till the water has evaporated. Similar methods are adopted with the other media. Each slide must be carefully numbered and labelled.

The following is a list of necessary apparatus:

Fine-pointed scissors.
Forceps.
Razors.
Scalpels.
Section-lifter.
Mounted needles.
Camel-hair brushes.
Watch glasses.
Reagent jars.
Test-tubes, beakers.
Spirit lamp.
Black and white mounting tile (enamelled).
Glass slides (3 in. × 1 in.).
Cover slips ($\frac{7}{8}$ in.).
Blotting-paper.
Drawing-paper (or Bristol board).
Hard pencils (HHH).
Labels for slides.
Slide box or rack.
Bell glass.
Lens.
Compound microscope.
Micrometer.
Objectives (1 in., $\frac{1}{4}$ in., $\frac{1}{6}$ in., $\frac{1}{8}$ in.).
Camera lucida.

Reagent bottles with dropping rods.
Glycerine.
Caustic potash, 5 per cent. solution.
Iodine solution.
Acetic acid.
Chlor-zinc-iodine.
Aniline sulphate solution.
Common salt, 5 per cent. solution.
Reagent rack.
Wash-bottles.
Elder pith.
Alcohol.
Distilled water.

The following works dealing with the morphology of plants may be consulted with advantage:

Biologie der Pflanzen.—Ludwig.
Morphologie der Pflanzen.—Pax.
Morphologische Studien.—Schumann.
Organography of Plants.—Goebel.
Comparative Anatomy of the Phanerogams and Ferns.—De Bary.
Anatomy of the Dicotyledons.—Solereder.
Vegetable Teratology.—Masters, M. T.

In addition to the first work quoted, there are a number of important works dealing with the biology of plants, which is a further or broader branch of botany, including the behaviour of plants in relation to environment or animals in general, a subject connected with physiology and uniting the two branches:

Insectivorous Plants, Fertilisation, and Forms of Flowers, Climbing Plants, etc.—Darwin.
Handbook of Floral Pollination.—Knuth.
Fertilisation of Flowers, and Alpenblumen.—Müller.
Natural History of Plants.—Kerner and Oliver.
Die Farben d. Bluthen.—Hildebrand.
Biologie und Anatomie der Lianen.—Schenk.

4. Bibliographical Work (for Advanced Systematic Botany).

Some suggestions as to the method of studying British plants from the systematic standpoint have been made under (1) *supra*. In order to prosecute the study of systematic botany upon a more scientific or more thorough basis a good deal of bibliographical research is necessary. For this reason a section is here devoted to the principal works required, dealing with special genera or memoirs and monographs on groups. The selection is by no means complete, but will afford the student assistance, it is hoped, in so far as main genera go. For a fuller list of British and foreign floras up to 1889, reference may be made to G. Egerton-Warburton's 'Names and Synonyms of British Plants,' where a list of authorities is given. More complete is Bentham and Hooker's 'Genera Plantarum,' 1862–1893, and 'Index Kewensis' up to date. The 'Journal of Botany' and 'New Phytologist' contain numerous other important papers, as well as the Journal and Transactions of the Linnean and other Societies. In a second list I have cited a few of the more important general works, British and foreign, for it should be understood that a proper knowledge of the British flora cannot be obtained without comparison with continental forms, therefore travel should be undertaken and reference should be made to the floras of the European countries and those of N. America. A much fuller list is given in the above works, and reviews of all important current floras will be found in the 'Journal of Botany.' These works are, moreover, contained in the large libraries at the British Museum, Kew, Linnean Society and elsewhere. (See also Williams's 'Prodromus.')

The third list includes a list of papers dealing with nomenclature, a thorny subject (which is well dealt with in

the 'Journal of Botany' from time to time, the Editor, Mr. J. Britten, being a specialist in this field), status, and distribution of British species. In this direction there are a large number of British botanists, specialists, who have an intimate knowledge of critical genera, and articles from their pens appear from time to time. The foremost authority in this matter is Mr. G. C. Druce, of Oxford, who has furthermore studied more counties of the British Isles in detail than any other British botanist, and probably knows more species, varieties, and forms than anyone else.

In regard to the general course to be followed in pursuing this study I cannot do better than refer the student to the introductory part of Willis's 'Manual and Dictionary of Flowering Plants and Ferns,' where suggestions as to how to proceed and the method of commencing work are given; and in this work the student will also find a list of selected orders to be studied enumerated.

Advice is further added as to how to use botanic gardens, recommended below, which should be followed (Dr. Willis is himself now in charge of the well-known Ceylon Gardens). Following this come notes upon botanical museums which should render invaluable aid by means of reference collections. Notes on general field work, outfit of collectors, collecting, preserving, and recording are also appended. The latter may be read in connection with section 1 (*supra*). The limits of space permit the author to give only a few other hints as to how to follow up special work in systematic botany. As most botanists have not the time or means to travel to every part of the British Isles to see or collect types of each species, a valuable substitute for this exists in the exchange clubs, the Watson Botanical Exchange Club (Secretary, G. Goode, Lyndhurst, De Freville Avenue, Cambridge), the British Isles Exchange Club (Secretary, G. C. Druce, Yardley Lodge, Crick Road, Oxford). A

subscription per annum is required, and each member is expected to contribute a parcel of plants each year, in return for which he or she receives a parcel of plants collected by other members, often amounting to one hundred of the rarer species. In addition reports are published giving valuable notes upon specimens collected or sent in for identification. There are some continental exchange media also, and dealers will supply foreign specimens of rare British species at a reasonable figure. Exsiccata or sets of plants are sometimes issued here and abroad, and these are also valuable aids to a knowledge of critical genera. A set of Rubi has been published by the Rev. W. M. Rogers, and a set of Hieracia by the Rev. E. F. Linton.

Access can be had to the large and valuable herbaria at the National Museum, and at Kew, and the authorities in charge give every facility for the study of material (British and foreign) under their charge, and besides are most ready to give any information that is desired, each member being a specialist. The same applies to the herbaria at Oxford, Cambridge, Edinburgh, Dublin, where valuable collections of recent or classic origin are preserved. The Linnean Society also possesses the Linnean Herbarium, which is of priceless value for an understanding of Linnean species.

There are also at Kew, Oxford, Cambridge, Edinburgh, and elsewhere botanic gardens where British or foreign types of plants are grown and where their living characters can be studied, in season, on the spot. Similar facilities, as in the case of the herbaria, are held out to anyone who wishes to study living plants, and the staffs will also take trouble to identify undetermined material.

The value of making one's own culture experiments of British plants is shown by the work of Hanbury on Hieracia, and of Linton on Hieracia and Willows, to

mention only two genera, and in these cases extensive series of plants were grown under observation for the purpose of study.

The recently established Botany School at Cambridge must be mentioned as a pioneer establishment for the better study of British systematic botany with efficient organisation for the encouragement of all who are interested in systematic botany (or ecology). Here, again, the same unfailing courtesy and patient endeavour to assist the inquirer or student meets one, and it cannot be too strongly urged that the general public should recognise the admirable facilities that exist for the furtherance of botany (in other domains alike) for those who will take the trouble to discover them.

Membership of scientific societies, such as the Linnean Society, where botany is one object of study, will bring the student into contact with other, and more advanced, workers, and this will have a stimulating and educative effect, apart from other material advantages to be gained.

The identification of material collected may be attempted with any of the following works, where details of habitat, flowering season, distribution, etc., are also to be found:

Handbook of the British Flora.—Bentham.

Handbook of British Flora (illustrated by Fitch).—Bentham and Hooker.

Student's Flora, 3rd edition.—Hooker.

Babington's Manual.

English Botany (Syme's edition).—Sowerby.

Hayward's Botanist's Pocket-book, 1909.—G. C. Druce.

The Cambridge Flora, vol. ii.—Dr. Moss.

Prodromus Floræ Britannicæ, vol. i.—F. N. Williams.

The following works are essential to the study of systematic botany:

Classification of Flowering Plants, vol. i.—Dr. A. B. Rendle.

Handbook of Systematic Botany.—E. Warming.
Floral Evolution.—H. F. Wernham.
The Classification of Angiosperms (review).—Dr. C. E. Moss. (And see also works reviewed.)
Genera of British Plants.—Dr. H. G. Carter.
Floral Diagrams.—Oliver.
Bluthendiagramme.—Eichler.
Types of Floral Mechanism.—A. H. Church.

### (1) *List of Special Papers, Monographs on Genera or Groups.*

*Ranunculus.* Papers by W. P. Hiern, 1871; Messrs. H. and J. Groves, F. N. Williams, 1908; Rev. E. S. Marshall, Ann. Sc. N. H., 1895, Journ. Bot., 1892. *Caltha.* J. F. Forster, Tr. Linn. Soc.

*Berberis.* Papers by Rev. E. S. Marshall, Journ. Bot., 1907.

*Fumaria.* The Genus Fumaria, H. W. Pugsley, 1912.

*Thlaspi.* Paper by G. S. Boulger, Journ. Linn. Soc.

*Lepidium.* Paper by C. E. Salmon, Journ. Bot., 1911.

*Capsella.* M. Jordan; E. A. Woodruffe Peacock, Journ. Bot., 1912.

*Barbarea.* Paper by T. R. Spragues and J. Hutchinson, Journ. Bot., 1908; R. J. Shuttleworth.

*Cochlearia.* Papers by Rev. E. S. Marshall, Journ. Bot., 1892, 1894.

*Viola.* Violæ Europæ, W. Becker; Mrs. E. S. Gregory, Monograph of British Violets; British Pansies, E. H. Drabble; paper by A. J. Willmott, Journ. Bot., 1911.

*Helianthemum.* Paper by Rev. E. S. Marshall, Journ. Bot., 1913.

*Tamarix.* P. B. Webb, 1840, monograph.

*Mœnchia, Silene, Dianthus.* Papers by F. N. Williams.

*Sagina.* Paper by W. Ingham and J. A. Wheldon.

*Cerastium.* Paper by G. C. Druce.

*Alsine.* Paper by W. P. Hiern.

*Spergula, Spergularia.* Papers by G. C. Druce.

*Hypericum.* Paper by C. E. Salmon.

*Rubus.* Handbook of British Rubi, Rev. W. M. Rogers, and papers in Journ. Bot.; papers by Rev. E. F. Linton; paper by Dr. Gilbert, Journ. Bot., 1907; paper by Babington, British Rubi, 1869; works of Dr. Focke; Bell Salter, British Brambles; A. Bloxam, Ann. N. H., 1850.

*Rosa.* The Genus Rosa, The Subsection Eucaninæ of the Genus Rosa, Major A. H. Wolley-Dod; "The Collection and Identification of Roses," Rev. A. Ley and Major A. H. Wolley-Dod; paper by Rev. A. Ley, Journ. Bot., 1907; papers by J. G. Baker, Crépin, Deseglise.

*Pyrus.* Paper by Rev. A. Ley; monograph by Prof. Hedlund.

*Saxifrages.* Papers by J. G. Baker, Rev. E. S. Marshall, W. H. Harvey, Journ. Bot., 1848.

*Epilobium.* Papers by Rev. E. S. Marshall, Journ. Bot.; Hybrids, R. H. Compton, Journ. Bot., 1911.

*Œnothera.* Papers by C. Bailey, G. A. Boulenger, Journ. Bot., 1907; B. M. Davis; work of Hugo de Vries on Mutations.

*Heliosciadum.* Paper by Rev. H. J. Riddelsdell.

*Arctium.* Paper by W. H. Beeby, Journ. Bot., 1908; A. H. Evans, Journ. Bot., 1913.

*Senecio.* Papers by Prof. A. H. Trow, Linn. Soc.

*Hieracium.* Monograph by F. J. Hanbury and J. Backhouse; British Hieracia, Rev. W. R. Linton; papers by Rev. E. S. Marshall, F. N. Williams, G. C. Druce, Rev. E. F. Linton, W. N. Shoolbred.

*Hypochœris.* Paper by A. Bennett, Naturalist.

*Taraxacum.* Monograph by Dr. H. Frei v. Handel Mazetti.

*Gentiana.* Paper by J. Britten, Journ. Bot., 1909.

*Anagallis.* Paper by Dr. C. E. Moss, Journ. Bot., 1911; Prof. F. E. Weiss.

*Limonium.* Papers by C. E. Salmon, Journ. Bot., 1907–1913.

*Armeria.* G. C. Druce, Linn. Soc.

*Erica.* Papers by Rev. E. F. Linton, Dr. A. B. Rendle, Journ. Bot., 1902.

*Cuscuta.* Paper by W. B. Hemsley, Journ. Bot., 1908.

*Limosella*, *Alectorolophus.* Papers by W. P. Hiern, Journ. Bot., 1910.

*Rhinanthus.* Papers by G. C. Druce, Rev. E. S. Marshall, Journ. Bot., 1903.

*Euphrasia.* Monograph by F. Townsend. Papers by Rev. E. S. Marshall, Ann. Scot. N. H., 1909; W. P. Hiern, Journ. Bot., 1907; F. H. Davey, G. C. Druce, Dr. von Wettstein, F. N. Williams (Prodromus).

*Orobanche.* Monograph by Dr. Ritter Beck von Mannazetta, Sutton, Tr. Linn. Soc., 1798.

*Utricularia.* Paper by G. C. Druce, Irish Nat., 1911; monograph by Dr. Gluck.

*Plantago.* Paper by R. M. Cardew and E. G. Baker, Journ. Bot., 1912, and J. Britten.

*Labiatæ.* Bentham, 1832–1836.

*Mentha.* Paper by J. W. White and J. G. Baker, Journ. Bot., 1865; W. Sole, 1798.

*Thymus.* Paper by Dr. K. Domin and A. B. Jackson. Rev. E. F. Linton, Journ. Bot., 1908; Irish Nat., 1909.

*Salvia.* Papers by G. C. Druce, H. W. Pugsley, Journ. Bot., 1908.

*Lamium.* Papers by Prof. G. S. Boulger, Journ. Bot., 1893; S. T. Dunn.

*Nepeta.* Paper by Eleanor Armitage, Journ. Bot., 1913.

*Ajuga.* Paper by A. Bennett.

*Prunella.* Paper by J. W. White, Journ. Bot., 1906.

*Salicornia.* Paper by Dr. C. E. Moss, Journ. Bot., 1911.

*Salsola*, *Euphorbia.* Papers by C. E. Salmon, Journ. Bot., 1907.

*Ulmus.* British Elms, Dr. C. E. Moss, Gard. Chron., Journ. Bot. Notes on British Elms, Rev. A. Ley, Journ. Bot.

*Quercus.* Paper by Dr. C. E. Moss, Journ. Bot., 1910.

*Salix.* Papers by Dr. White, Rev. E. F. and W. R. Linton, Rev. E. S. Marshall.

*Helleborine*, *Epipactis.* Papers by G. C. Druce, Journ. Bot., 1908, 1909.

*Amaryllidaceæ.* Dean Herbert, 1837.

*Iris.* The Genus Iris, W. R. Dyke.

*Crocus.* The Genus Crocus, G. Mawe.

*Convallaria.* Paper by G. C. Druce.

*Paris.* Paper by E. W. Swanton.

*Luzula.* Paper by E. W. Hunnybun.

*Alisma.* Paper by Rev. E. S. Marshall.

*Sagittaria.* Paper by W. P. Hiern, Journ. Bot., 1908.

*Sparganium.* Paper by W. H. Beeby, Journ. Bot., 1885.

*Potamogeton.* Monograph by A. Fryer. Papers by A. Bennett, Journ. Bot., 1883, 1907, etc.

*Naias.* Paper by Dr. A. B. Rende, Linn. Soc.

*Carex.* Anatomy of, F. C. Crawford; illustrations of, C. B. Clarke, and F. Booth, 1858–1867; monograph, Pfarrer G. Kükenthal. Papers by A. Bennett, Journ. of Bot., 1893, Naturalist, etc.; Rev. E. S. Marshall, Journ. Bot., 1898; G. C. Druce, *ibid.*, 1909, 1910, Ann. Scot. N. H., 1909, Linn. Soc., 1898, etc.; F. N. Williams, etc.; Bishop Goodenough, Tr. Linn. Soc.

*Cyperaceæ.* G. C. Druce, Ann. Scot. N. H., 1910.

*Graminaceæ.* Monograph of Festuca, etc., Prof. E. Hackel.

*Capriola.* Paper by W. P. Hiern, Journ. Bot., 1899.
*Spartina.* Paper by Dr. O. Stapf.
*Melica.* Paper by H. and J. Groves, J. Britten, Dr. C. E. Moss, Dr. A. B. Rendle, Journ. Bot., 1909.
*Poa.* Paper by G. C. Druce, Journ. Linn. Soc.
*Kœleria.* Paper by Rev. E. S. Marshall, Journ. Bot., 1906; G. C. Druce, Ann. Scot. N. H., 1906.
*Festuca.* Paper by Rev. E. S. Marshall, Journ. Bot., 1890.
*Apera.* Paper by A. B. Jackson, Ann. Scot. N. H., 1907.

Other papers will be found in the Journal of Botany, 'New Phytologist,' and other scientific journals.

(2) *List of Older or more General Works and of Continental Floras.*

For a more complete list of these any good flora in which authorities of groups, orders, genera, etc., are given, may be consulted. Mr. F. N. Williams' 'Prodromus Floræ Britannicæ,' which goes only so far as Sympetalæ as yet, gives the most thorough citation of synonyms and references, whilst reference may be made to Syme, Bentham and Hooker, Index Kewensis, Durand's Index. The New Cambridge Flora, by Dr. C. E. Moss (Vol. II only published as yet) also gives synonyms, but is not far advanced enough towards completion yet to take the place it will obviously fill in this direction.

Early works by Ray, Hudson, Miller, Curtis, Withering, Hill, How, Tournefort, Linnæus, and others.
English Botany.—Syme.
Genera Plantarum.—Bentham and Hooker, 1862–1893.
Das Pflanzenreich.—Engler, 1892–96.
Die Natürlichen Pflanzenfamilien.—Engler and Prantl.
Flore de France.—Rouy and Foucaud, 1896.
Synopsis der Mittel-Europæischen Flora.—P. Ascherson and P. Graebner, 1912.

Flore de France.—Georges Rouy, 1912.
Icones Floræ Germanicæ.—H. G. Reichenbach, 1823.
Flore de France.—Grenier and Godron, 1848–1856.
Synopsis Floræ Germanicæ et Helvetiæ.—W. D. J. Koch, 1837.
Flore de l'Ouest de la France.—J. Lloyd, 1854.
Flore de la Normandie.—L. A. de Brébisson, 1856.
Flore des environ de Paris.—Cosson and Germain, 1845.
Flore du centre de la France.—A. Boreau, 1840.
Novitiæ Floræ Suecicæ.
Summa Vegetabilium Scandinaviæ.—E. M. Fries, 1846–49.
Plantæ Scandinaviæ. Andersson, 1849–1852.
Ried Gräser.—C. Schkühr, 1840–1850.
Conspectus flora Europææ.—C. F. Nyman, 1854–55.
Prodromus.—De Candolle, 1824–1873.
Prodromus Floræ Hispanicæ.—M. Wilkomm and J. Lange, 1861–1880.
Flore de Schweiz.—Schinz and Keller.

(3) *List of Papers, etc., dealing with Nomenclature, the Status of the British Flora, and the Distribution of Species.*

"The Status of some Britannic Plants," Rev. E. S. Marshall, Journ. Bot., 1906.
"On the Probable Status of some Irish Plants," *idem.*, *ibid.*, 1899.
"Remarks on the Cybele Hibernica," ed. 2, *idem.*, *ibid.*, 1899.
"Irish Topographical Botany" (Review), *idem.*, *ibid.*, 1899.
"Comital Census Numbers," G. C. Druce, *ibid.*, 1909.
"On the Distribution of Rubi in Great Britain," Rev. W. Moyle Rogers, *ibid.*, 1902.

"On the Rubi List in the 'London Catalogue,'" ed. 9, Rev. W. Moyle Rogers, Journ. Bot., 1895.

"Druce's List of British Plants" (Review), H. H. Rushby and N. L. Britton, Torreya, 1907.

"Notes on the New Edition of Babington's 'Manual of British Botany,'" G. C. Druce, Ann. Scot. N. H., 1905.

"The Nomenclature of British Plants," *idem.*, *ibid.*, 1907.

"Notes on English Botany Supplement," *idem.*, *ibid.*, 1892.

"On the British Plant Lists and their Discrepancies," *idem.*, *ibid.*, 1909.

"The Oxford British Plant List," *idem.*, Naturalist, 1909.

"Linnæus's 'Flora Anglica,'" *idem.*, Journ. Bot., 1913; J. Britten, *ibid.*

"Index Abecedarius: an alphabetical index to the first edition of the 'Species Plantarum' of Linnæus," W. P. Hiern.

"International Rules for Botanical Nomenclature," Vienna, 1905.

"Notes on the Drawings for Sowerby's English Botany," F. N. A. Garry.

"London Catalogue of British Plants" (10th edition).

"List of British Plants," G. C. Druce.

"British Seed Plants," J. Britten and A. B. Rendle.

"First Records of British Flowering Plants," W. A. Clarke, 1900.

"Notes on the London Catalogue" (10th edition), Rev. E. S. Marshall, 1908.

"Notes on the List of British Seed Plants," A. B. Rendle and J. Britten, 1907.

"Species Plantarum," "Genera Plantarum," C. Linnæus.

"Index Kewensis," B. D. Jackson.

*Ibid.*, Durand's Supplement.

"Icones Plantarum," Pritzel.

"Botanischer Jahresbericht," Jost.
"Genera Plantarum," Bentham and Hooker.
"Topographical Botany," H. C. Watson.
*Ibid.*, Supplement, A. Bennett, 1903.
"Cybele Britannica," H. C. Watson.
"Cybele Hibernica" (2nd edition), Moore and A. G. More 1898.
"Irish Topographical Botany," R. L. Praeger.

## 5. Fossil Botany.

The classification of plants is intimately connected with their phylogeny or race history, which, though to be unravelled by the study of ontology or the embryology of plants, has not so far been settled by this method, as the vegetable embryo has not as yet revealed the same indications afforded by animals. Therefore the appeal to phylogeny is the greater in the case of plants, especially as comparative anatomy in this case again does not so far supply the answer satisfactorily. Plants are more plastic, and conceal original characters more completely than animals.

There has been, moreover, a great advance made in the knowledge of fossil plants and ancient floras during the last ten years, largely through the labours of British botanists —Williamson, Scott, Seward, Kidston, Stopes—and more recently through those of Wieland, in America; Zeiller, Laurent, Lignier, Renault, on the Continent.

Two main considerations prompt an inquiry into the geological history of plants—a desire to discover the origin of the British flora, and the origin of angiosperms; and related to the latter also is the question of the origin of gymnosperms, and that of monocotyledons and dicotyledons.

Two eras have largely contributed hints upon these questions—the Carboniferous and the Jurassic (and Cretaceous).

The discovery of synthetic types or seed plants amongst "ferns" and Lycopods in the Coal-measures furnished the preliminary evidence for tracing the descent of higher forms from these, and for constructing a genetic sequence. This was simultaneously coupled with the discovery of the equally synthetic Jurassic *Bennettites*, or cycad-like type, with a flower or inflorescence like that of modern plants, and suggesting an angiospermic ancestor, resembling types of Ranales—*e.g. Magnolia.* The connection suggested between such ancient types and the best known group of modern plant groups quickened general interest in the origin of angiosperms. The discovery in Portugal and elsewhere of early angiosperms, monocotyledons, and dicotyledons, which appeared suddenly together, had already paved the way for a wider interest in early plant types.

Similarly, in regard to the origin of the British flora, the existence of southern plants in Ireland and South-west England, and of American plants in Ireland and Scotland, in spite of the extensive glaciation of England, presumably precluding the survival of the former through such a cold period, has always presented an apparently unsolvable mystery as to the presence of the former alongside of northern plants (which predominate) in these islands. The origin of this composite flora, indeed, still remains in debate. The work of Mr. Clement Reid in the plant-beds of East Anglia and elsewhere has produced a rich harvest of results, showing that many plants living to-day flourished in pre-glacial times along with others not now living here but natives of the Mediterranean area. Mr. Reid thinks various accidental agencies have enabled the present flora to become established, and does not think that possible former land bridges explain the distribution of the isolated florulas.

Fossil botany is thus a fascinating branch of botany and may be pursued as other branches of palæontology by

careful collection in the field, and patient research at home in the identification of species, or the elucidation of botanical structures. Microscopic slides of well-preserved carboniferous plants afford as much detail as those of modern plants, and structural palæobotany is of even greater importance and value than systematic fossil botany, or the study of form and outline, or external characters.

The literature of fossil botany has already assumed alarming proportions for the specialist. In order to assist the beginner the following works, or references to sources, are given:

Studies in Fossil Botany, 2 vols., 2nd edition.—Dr. D. H. Scott.

Fossil Plants, Vols. I–II.—Prof. A. C. Seward.

The Evolution of Plants.—D. H. Scott.

Links with the Past in the Plant World.—Prof. A. C. Seward.

Ancient Plants.—Dr. Marie C. Stopes.

Elements de Palæobotanique.—M. Zeiller.

Fossil Botany.—Graf. zu. Solms Laubach.

The Geological History of Plants.—Sir J. W. Dawson.

American Fossil Cycads.—G. R. Wieland. (See also the works of Laurent and Lignier.)

Catalogue of Palæozoic, Triassic, Liassic, Jurassic, Wealden Plants in the British Museum, and of the Glossopteris Flora, Cretaceous Plants (in the press).

Palæontographical Society's Memoirs on Carboniferous and Eocene Floras.

Philosophical Transactions, Royal Society, Memoirs on the Organisation of Fossil Plants of the Coal-Measures, by W. C. Williamson, D. H. Scott, and other papers by Prof. A. C. Seward, E. A. N. Arber, Dr. R. Kidston (and in Transactions, Royal Society of Edinburgh), Prof. F. W. Oliver, Dr. M. C. Stopes, etc.

The Geological Magazine; Quarterly Journal Geological Society; Transactions Linnean Society; Journal Linnean Society; Journal of Botany; Memoirs Geological Survey, contain various papers on fossil plants.

Origin of the British Flora.—C. Reid.

Submerged Forests.—*Idem.*

Besides the above there are a large number of special papers and monographs upon the systematic position and description or morphology of fossil plants, lists of which will be found in the above works. Dr. J. Yongmans, of Leiden, has also published papers on the bibliography of the subject, which should be consulted, as well as other papers on special aspects of palæobotany in the *Progressus Rei Botanicæ.*

# INDEX

Figures in heavy type indicate the page at which a detailed description of the class, subclass, group or species is to be found. Numbers in brackets refer to the explanations of illustrations, where also the number of the illustration is given.

ADLARD AND SON, IMPR., LONDON AND DORKING.